Annals
of the
Missouri Botanical Garden

Volume XXIX

1942

With Thirty-four Plates and Sixty-nine Figures

Published quarterly at Fulton, Missouri, by the Board of Trustees of the Missouri Botanical Garden, St. Louis, Mo.

Entered as second-class matter at the post-office at Fulton, Missouri, under the Act of March 3, 1879.

Annals

of the

Missouri Botanical Garden

A Quarterly Journal containing Scientific Contributions from the Missouri Botanical Garden and the Henry Shaw School of Botany of Washington University in affiliation with the Missouri Botanical Garden.

Information

The ANNALS OF THE MISSOURI BOTANICAL GARDEN appears four times during the calendar year: February, April, September, and November. Four numbers constitute a volume.

Subscription Price........$6.00 per volume
Single Numbers.......... 1.50 each*

Contents of previous issues of the ANNALS OF THE MISSOURI BOTANICAL GARDEN are listed in the Agricultural Index, published by the H. W. Wilson Company.

* Except No. 3 of Vol. 22, price $5.00, and No. 2 of Vol. 25, price $2.50.

ANNALS

OF THE

MISSOURI BOTANICAL GARDEN

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Annals
of the
Missouri Botanical Garden

Vol. 29 FEBRUARY, 1942 No. 1

CONTRIBUTIONS TO OUR KNOWLEDGE OF AMERICAN CARBONIFEROUS FLORAS[1]

I. SCLEROPTERIS, GEN. NOV., MESOXYLON AND AMYELON

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The occurrence in America of the petrifactions known as coal-balls has been known for many years and in itself needs no review. It is, however, still rather generally accepted that American coal-balls are by no means the equal of the renowned English specimens that have yielded such a wealth of information concerning the flora of Carboniferous times. Much of the American material is highly pyritized, and although pyrite does not necessarily render the petrifactions worthless it is not the most desirable preserving mineral. Pyritized material from the English mines is by no means unknown, while many of the American specimens are quite free from pyrite or contain but insignificant quantities and the plants contained in the coal-balls often exist in an exquisitely fine state of preservation.

It has been my privilege to study rather carefully most of the great English collections of petrified Carboniferous plants, and from a comparison of those with some hundreds of Illinois specimens that have recently come into my laboratory there is no doubt that the better ones are equally as well preserved as the English. The commonly encountered "open pit" method of mining in our central states is making huge quantities of material available, and much may be expected of the ensuing studies on American paleobotany during the coming years. It must be remembered, moreover,

[1] A study financed in part by a grant from the Penrose Fund of the American Philosophical Society.

Issued February 18, 1942.

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that the outstanding English collections and the slides dispensed by professional petrologists represent the choice selections of nearly a century of labor, while almost nothing has been done with American coal-balls until a very few years ago. It is safe to assert that when our own flora is better known it will not suffer by comparison.

Although a considerable number of species have already been reported from the petrifactions of the midwestern states (Darrah, '41), few comprehensive studies have been undertaken. It is planned to present here, and in the following parts of this series, descriptions of the plants composing the coal-ball flora, chiefly of southern Illinois. As it is not possible to present the results of such a study in phylogenetic order without undue delay, they will appear as adequate material of the genera is collected and studied.

All of the specimens on which the present paper is based were collected by the author and his students from the open-pit Pyramid Mine of the Binkley Coal Co., located about three miles south of Pinckneyville, Perry County, Illinois. I wish to express my appreciation for the very generous assistance and cooperation extended to me during many visits by officials and employees of that mine.

The petrifactions are abundant, although, as might be expected, they are by no means uniformly distributed through the coal. One may chance upon a "nest" of half a ton or more or wander along the seam for a mile without encountering any. The better coal-balls are usually found near the top of the seam, sometimes a foot or so below the surface, but more often than not in sheet-like aggregations, their tops flush with the surface of the coal. They are easily detected when the latter is exposed and slightly weathered. The mineral content of these more or less unit aggregations seems to be quite constant, and in many cases they are very nearly free of pyrite. Thus it is a rule that when one or two good specimens are picked up, dozens of others are near at hand.

The better coal-balls lend themselves readily to the preparation of satisfactory nitrocellulose peels, although it has been found necessary in some instances to use them in conjunction with ground sections.

Arborescent Lycopod stem remains constitute the dominant floral feature of our collections. Associated with them are *Lepidophyllum, Stigmaria* and *Lepidocarpon.* A consideration of the stems and leaves will be presented at a later date, while a description of a remarkably well-preserved gametophyte and the microsporangiate

cones of *Lepidocarpon* constitutes the second contribution of this series (see p. 19). Stems and roots of *Sphenophyllum* are well represented and fructifications probably referable to *Scolecopteris* occur in many specimens. *Heterangium* is also present. Stems and roots of *Mesoxylon* are common, and these, together with a new genus of coenopterid ferns, will be considered in the following pages.

Scleropteris illinoiensis Andrews, gen. et sp. nov.

General Anatomy and Procedure.—

Our knowledge of this pteridophyte is derived from a small portion of a branched stem which, although fragmentary, is excellently preserved. Since but one specimen has been encountered in some hundreds of coal-balls, it seems desirable to describe it without further delay. As will be pointed out in the following pages, *Scleropteris* resembles in some respects *Botrychioxylon* and *Zygopteris* but certain highly distinctive features of the cortex, as well as the tracheidal pitting, set it apart from these two genera (or one, as Sahni ('32) has shown may be the case).

The specimen was about 6 cm. long and branched twice. Prior to the first division, an equal dichotomy, the stem measured 1.3 cm. in diameter. Shortly after the dichotomy of the stele the stem became somewhat flattened, measuring 1 × 2 cm., and the two resultant branches each measured 1 cm. in diameter. These figures are necessarily approximate due to some slight crushing and distortion.

The most distinctive feature of the stem lies in the sclerotic nests scattered through the broad cortex. The stele consists of a mixed primary body surrounded by more or less radially arranged tracheids presumably of secondary origin. Adventitious roots are numerous.

The specimen was cut into three slices perpendicular to the long axis of the stem. The central section was used for a series of longitudinal peel preparations, the other two for transverse sections. Unfortunately, the initial saw cut passed directly through the point of dichotomy of the stele.

Preparations made by the nitrocellulose peel technique proved very satisfactory. In fact, in this particular case they were superior both for study and photographic purposes to ground sections. It was found that by photographing the peels unmounted, rough side down, against a black background, excessive reflection was reduced and much finer detail was obtained than when the peels were mounted in balsam.

The Stele.—

Figure 2 of pl. 1 represents a transverse section of the entire stem prior to dichotomy, while fig. 1 shows it shortly above the division of the stele. It may be noted that the dichotomy is equal, both branches (pl. 1, fig. 1, st_1, st_2) being approximately the same size. The stele itself, taken from a point about 1 mm. above the section represented in fig. 2, is shown more highly enlarged in fig. 3. At this point, which is immediately prior to dichotomy, it is oval-shaped but is otherwise nearly circular in cross-section (pl. 3, fig. 11). There the stele measures 2 mm. × 3.5 mm., while after division the resultant branches are approximately 1.3 mm. in diameter.

The central part of the stele is mixed, being composed of small tracheids scattered through the parenchyma cells. The latter may be isodiametric but for the most part are vertically elongated, being 2–4 times as long as broad. It is not possible to distinguish definitely protoxylem elements in transverse section. In median longitudinal sections, however, small scalariform tracheids may be observed near the periphery of this primary mass (pl. 2, fig. 7, *px*). It would thus seem that the primary wood was mostly centripetal, as is probably the case in *Botrychioxylon paradoxum,* but this point is not without an element of doubt in both species.

Around the mixed primary xylem there is a zone of larger tracheids, for the most part radially arranged and presumably secondary in origin. These are uniformly pitted on both radial and tangential walls. Some of the small tracheids located near the inner margin are scalariform but all of the larger ones possess multiseriate bordered pits although they may be slightly elongated horizontally (pl. 2, fig. 7). With reference to the pitting of *B. paradoxum,* Scott ('12) writes: "The large tracheids of the secondary wood have scalariform markings, the bars being often short, so that there are two or three series on the same wall." [p. 376]. His fig. 21, pl. 41, bears out this description. The pits are much less closely compacted in *Scleropteris,* and although there are transitions between scalariform and nearly circular bordered pits the latter are distinctly predominant.

Since no tangential sections of *B. paradoxum* were prepared, the presence of wood rays was left in question. Scott writes: "It is doubtful whether true medullary rays are present; if so they must be very few in number. Transverse sections afford no decisive proof of their existence." [p. 375]. It is likewise difficult to discern rays

with certainty in the cross-sections of *Scleropteris* but serial longitudinal sections reveal their presence. A tangential section from near the outer margin of the secondary wood (pl. 3, fig. 12) shows uniseriate rays of great height.

The secondary wood is not extensive, varying from 5 to 9 cells wide. The cells are, for the most part, radially arranged and occasional evidence of cambial activity at the periphery leaves little doubt as to its true secondary origin.[1]

Although the tissues immediately outside the xylem are not as well preserved, in certain sections there may be observed a narrow phloem, a pericycle two cells wide and what appears to be an endodermis the cells of which are filled with a very dark substance. The endodermis is, however, not readily distinguishable in most sections, as might be expected where an appreciable amount of secondary growth has taken place.

The Cortex.—

The most prominent feature of the stem lies in the abundant sclerotic nests scattered through the cortex (figs. 1, 5, 6 of pls. 1–2). Although rather irregularly shaped they appear more or less isodiametric in cross-section and slightly elongated longitudinally (figs. 5, 6). The sclereids composing the nests are very thick-walled, in some the lumen being almost lacking. Like the nests as a whole, they are slightly elongated longitudinally.

The outer parenchymatous cortical cells contain an abundance of branching fungal filaments. Although they may compose the mycelium of a decay organism, their aggregation within the cells suggests a mycorrhizal relationship.[2]

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[1] It is evident from recent anatomical studies that the distinction between primary and secondary vascular tissues is not as sharp a one as was once supposed, and it is possible that these radially arranged tracheids have had their origin from a multiple ("primitive") cambial layer rather than a single row of meristematic cells.

[2] *Mycorrhizae and the origin of roots:* The presence of mycelium in the tissues of fossil plants is not uncommon, and it occurred to me some few years ago that there might be a deeper lying significance to this association than most authors realized. The idea, and I do not claim absolute priority although I know of no published formulation of it, seems worthy of some thought. Briefly stated, it seems possible that mycorrhizae or a mycorrhizal-like association were a deciding factor in the establishment of the higher land plants and that root hairs and rhizoids are the result of later specialization in the higher vascular plants and the lower vascular plants and bryophytes respectively.

It is supposed that mycorrhizal associations existed prior to the evolution of the normal absorbing organs of these plants and that as the aquatic ancestors migrated landward the mycorrhizae made possible this new habitat; and as these newly arrived land plants

The cells of the outermost cortical layers and epidermis are arranged in peculiar mounds which seem to represent the basal portions of emergences (pl. 1, fig. 4). Whatever was the nature of such emergences is not known. Most of them terminate in a flat top as shown in fig. 4. That they do represent the basal part of a superficial appendage seems certain as their remnants are present in some of the sections and none show evidence of having possessed vascular tissue.

Petioles are lacking in the single available specimen. It was thought at first that the small branch shown at the right of fig. 5 might be a petiole but the serial longitudinal peels reveal no positive evidence of a leaf gap at its junction with the main stem stele. The specimen is, then, either a fragment of a plant bearing rather widely separated nodes or it is one in which there is no distinct segregation of the shoot system into stems and leaves as they typically occur in more recent groups.

Roots.—

Adventitious roots are numerous throughout the specimen. Three may be seen in various stages of departure from the stele in pl. 1, fig. 3. The passage of the root stele through the cortex is irregular but in most cases it appears to be upward at an angle of about 30° with the stem stele. It is not possible to determine for certain the number of protoxylems. There seems to have been some secondary xylem, as well as cork cambial activity, and the cortex is comparatively broad.

Diagnosis.—

A dichotomously branching stem 1–1.3 cm. in diameter; stele consisting of a central mixed primary region, probably centripetal in development, surrounded by a zone of radially arranged tracheids

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became better adapted to their new habitat they developed rhizoids or root hairs and roots which gradually replaced the fungus. There are a number of points that lend support to such a hypothesis. Roots are lacking in the earliest land plants but rhizoids are present and in certain cases fungal associations that may be mycorrhizae; roots are not strongly developed in the higher vascular cryptogams as a whole; in certain seed plants it is well known that germination of the seeds and early growth of the young seedling is difficult or impossible without mycorrhizae.

The possibility is, of course, clearly recognized that the rhizoid-like structures present in the algae may have given rise directly, in all instances, to the corresponding structures in early land plants. This concept of the part that mycorrhizae may have played is presented for what it may be worth.

bearing multiseriate bordered pits on radial and tangential walls; prominent sclerotic nests scattered through cortex.

Affinities of Scleropteris.—

As far as stelar structure is concerned, the affinities of this genus appear to lie with the zygopterid ferns, with which it agrees in the division of the stele into a central mixed pith and a peripheral region of comparatively large tracheids. In both *Ankyropteris* and *Zygopteris* a weak development of secondary wood has been reported. Compared to these two, the tracheids of *Scleropteris* seem to be much more regularly arranged and more distinctly secondary. Of the described species of *Ankyropteris* the closest comparison is with *A. corrugata* (Holden, '30) but in that species the tracheids are typically scalariform, quite in contrast to the multiseriate and nearly circular pits of *Scleropteris.* The closely compacted leaf bases of *Zygopteris* and the branching of the stem in *Scleropteris* present contrasting characters which sharply separate these two genera.

The cortical sclerotic nests of *Scleropteris* constitute the most distinctive feature of the fossil and set it apart from any other fern referred to the Coenopteridineae (classification of Hirmer, '27). These structures are of interest not only for their diagnostic value but because they suggest these possible affinities with the pteridosperms. First, one of the most prominent features of that group is the dictyoxylon cortex so strikingly displayed in *Lyginopteris.* It seems evident that this tissue must have had its origin in a less highly organized arrangement of parenchymatous and sclerotic or fibrous cells, and the scattered, slightly vertically elongate nests of *Scleropteris* may represent a step in that direction. Second, the radial arrangement of the tracheids indicating weak cambial activity points in a gymnospermous direction.

Mesoxylon.—

Judging from the frequency of occurrence of Cordaitean stems and roots in the Pyramid Mine petrifactions, this group was well represented in the Carboniferous Lycopod forests of southern Illinois. The stem remains described below are referable to *Mesoxylon,* and although in themselves they present only such features as are already known in the five English species, it has been possible to demonstrate that roots of the *Amyelon* type, long considered to be of Cordaitean affinities on the basis of association, actually occur in organic connection with *Mesoxylon.*

The stems are fairly well preserved and the roots exquisitely so. It has not been possible, however, to work out satisfactorily the structure and course of the leaf traces or leaf bases, and as these have been used chiefly in delimiting species it seems advisable to assign a new specific name to our specimen. The most significant point in the present discussion lies not in the recording of another species of *Mesoxylon* based on trivial or even negative characters but in the presentation of conclusive proof that *Amyelon* is the root of a Cordaitean stem.

The stems attain a diameter of little more than 2 cm. including extra-stelar tissues. The pith in the larger specimens averages about 14 mm. and is typically chambered. The peripheral region consists of large parenchymatous cells about 105 μ in diameter by 60 μ high which are arranged in rather regular vertical rows.

Surrounding the pith are prominent masses of primary wood. These are sufficiently well preserved to state with reasonable certainty that the protoxylem is mesarch (pl. 3, fig. 10). The latter seems to be the only distinctive generic character of *Mesoxylon* segregating it from Cordaites, and in view of the otherwise close similarity between the two the validity of its use as a generic character must be looked upon with some doubt. In a previous paper ('40) I have dealt with the variability in the primary body of the pteridosperms and other groups and have pointed out that the position of the protoxylem must be used with reservation as a taxonomic character.

The tracheids of the secondary wood range in cross-section from 15 × 21 μ to 21 × 30 μ, the tangential dimensions being somewhat greater in most cells. As is usual in Cordaitean stems, there is a broad pitting transition zone bordering the pith, the innermost tracheids being spirally thickened. These are followed through a radial distance of about 10 cells by scalariform, reticulate, and pitted cells. The latter are not well preserved, and it is not possible to determine the number of rows of pits per cell. The rays are uniseriate and low, ranging from 1 to 3 cells high (pl. 4, fig. 17) with an occasional ray 4 or 5 cells high.

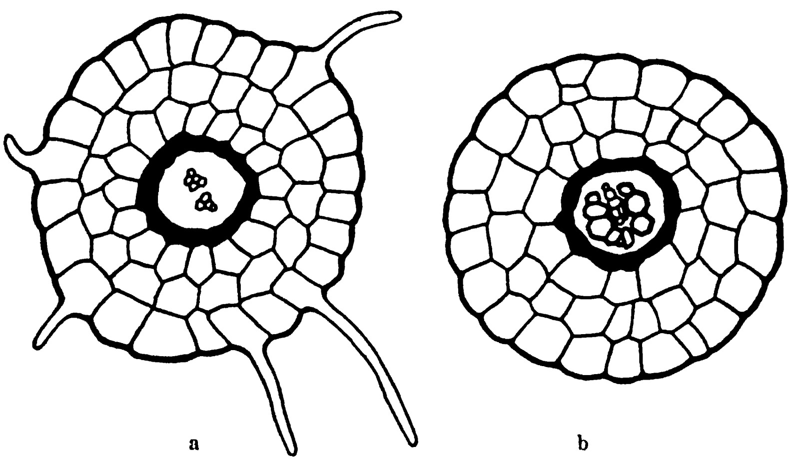
Roots.—

Well-preserved roots belonging to the form genus *Amyelon* and associated with Cordaitean stem remains have long been known from the Carboniferous of Europe and have more recently been reported in coal-balls from Iowa (Wilson and Johnston, '40). The

specimens in our collections from the Pyramid Mine consist of minute rootlets bearing well-preserved hairs up to larger roots 3 mm. in diameter.

There is some question as to the identity of the smallest rootlets, but their association with the older typical specimens of *Amyelon* strongly suggests that they belong to that genus.

In the youngest roots (text-fig. 1*a*) the diarch primary xylem consisting of only 8 or 10 cells, may be observed in the center. All of the roots, young or old, studied thus far are diarch, and the development of the metaxylem is, of course, entirely centripetal. The phloem is not preserved but immediately outside the position it ap-



Text-fig. 1. Rootlets, probably of *Mesoxylon*. In *a* there may be observed the large epidermal cells with root hairs, two layers of cortical cells, the dark endodermis and the diarch primary xylem. In *b* a few secondary xylem cells are present. WCB31F.T5. × 84.

parently occupied is an endodermis the cells of which are filled with a dense brown substance (text-fig. 1, fig. 8). Beyond this is a cortex of larger, thin-walled cells slightly elongated longitudinally. The cells of the epidermis are somewhat larger and thicker-walled.

One of the most interesting features of these rootlets is the beautiful preservation of the root hairs. These may be seen in pl. 3, fig. 8 and at higher magnification in fig. 9. They are clearly typical root hairs, being outgrowths of the epidermis and composed of but a single cell. Most of the young roots show a trace of secondary xylem starting to form (text-fig. 1*b*).

In all the older roots the secondary wood is strongly developed (pl. 4, fig. 16). This is followed by a narrow band of phloem and a

cortex of rather large cells many of which appear to be resinous.

The development of periderm started early and all except the smallest roots possess some. The origin of this cork cambial activity was not as deep seated as described by Osborne ('09) for the English specimens, since an appreciable thickness of cortex remains in the older roots. As far as this feature is concerned, the roots described here seem to be intermediate between the English ones and those described by Renault ('79) from France.

The question of the natural affinities of the roots may now be considered. In 1879 Renault noted their association with Cordaitean stems and wrote:

> "Au milieu des mêmes fragments silicifies que renferment les rameaux et les feuilles de Cordaitales on trouve souvent des débris de racines, dont la structure offre une analogie suffisamment grande avec celle des tiges de ces plantes, pour qu'on puisse les regarder comme ayant appartenu à ces dernieres." [p. 294].

The apparent although unproven significance of this association seems to have been accepted by most paleobotanists, although nearly half a century later Scott ('23) wrote with reference to *Amyelon* that, "they agree so well in histological structure with the stem, that there is no reason to doubt the correctness of Renault's conclusions, that they belonged to the same plants, though I am not aware that roots showing structure have yet been found in actual connection with the stem." [p. 286].

One of our *Mesoxylon* specimens has been found with *Amyelon* roots in actual organic connection, and figs. 13–14 of pl. 4 represent three successive ground sections through part of the stem. In the upper right of fig. 13 a noticeable bulge appears in the periphery; in the next section (fig. 14) the departing adventitious root is very prominent while in the next (fig. 15) it is almost clear of the stem. Fortunately the root was preserved in such a position that immediately after departing from the stem it lay parallel to the latter. Thus, fig. 15 shows the outer part of the root in transverse section and in the next section (fig. 16) the root appears quite separate from the stem and in perfect transverse section. At the left of fig. 15 another root may be seen departing from the stem.

The American and European specimens of *Amyelon* are all so nearly alike that it can now be certainly asserted that they belong to Cordaitean stems. As is usual with roots, their anatomy is more stereotyped than the other vegetative organs, and there seem to be no known dependable characters that make possible the delimitation

of distinct species of *Amyelon*. The chief variations in the roots are size, number of protoxylem poles and relative origin of the periderm with reference to the cortex, and none of these (with the possible exception of the last) is sufficient for specific segregation.

Mesoxylon Nauertianum Andrews, sp. nov.

Diagnosis.—

Stems 2 cm. or more in diameter; pith large and chambered; peripheral cells arranged in vertical rows; protoxylem mesarch; secondary xylem tracheids averaging 18 × 25 μ in cross-section, pitting transition broad, rays uniseriate and mostly 1–3 cells high; roots in organic connection with the stem of the *Amyelon* type.

The species is named in recognition of Mr. N. H. Nauert whose willing assistance in the field and ability as a technician has greatly facilitated my coal-ball studies.

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EXPLANATION OF PLATE

PLATE 1

Scleropteris illinoiensis

Fig. 1. Transverse section through the stem showing dichotomy of the stele, *st*. WCB90B.B11, × 4.5.

Fig. 2. Transverse section through the stem; *sc*, sclerotic nests; *st*, stele. WCB90C.T15, × 5.5

Fig. 3. Transverse section through the stele; *mp*, mixed pith; x_2, secondary xylem; *r*, departing root. WCB90C.T2, × 20.

Fig. 4. Longitudinal section through the outer cortex showing bases of emergences. WCB90B.S22, × 17.

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Explanation of Plate

PLATE 2

Scleropteris illinoiensis

Fig. 5. Longitudinal section showing branching of stem: *st*, stele; *sc*, sclerotic nests. WCB90B.S35, × 4.

Fig. 6. Longitudinal section through cortex showing an emergence and sclerotic nests. WCB90B.S27, × 8.

Fig. 7. Radial longitudinal section through stele: *px*, protoxylem (?). WCB90B.S22, × 150.

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ANDREWS—AMERICAN CARBONIFEROUS FLORAS. I

Explanation of Plate

PLATE 3

Fig. 8. Rootlet, probably belonging to ***Mesoxylon***, bearing root hairs. WCB31F.T4, × 93.

Fig. 9. Portion of another rootlet shown at a higher magnification. WCB31F.T4, × 260.

Fig. 10. ***Mesoxylon Nauertianum***. Portion of the stem showing centripetal development of the primary xylem: *p*, pith, *pr*, protoxylem, *m*, centripetal metaxylem, x_2, secondary xylem. WCB53B–B.S8, × 80.

Fig. 11. ***Scleropteris illinoiensis***. Tangential section through the central portion of the stem; *r, roots*. WCB90C.T9, × 20.

Fig. 12. ***Scleropteris illinoiensis***. Tangential section through the secondary xylem showing tracheids and rays. WCB90B.S32, × 70.

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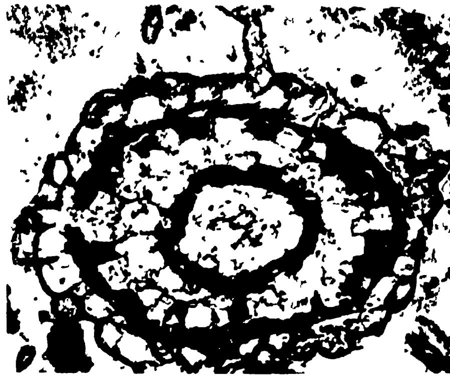

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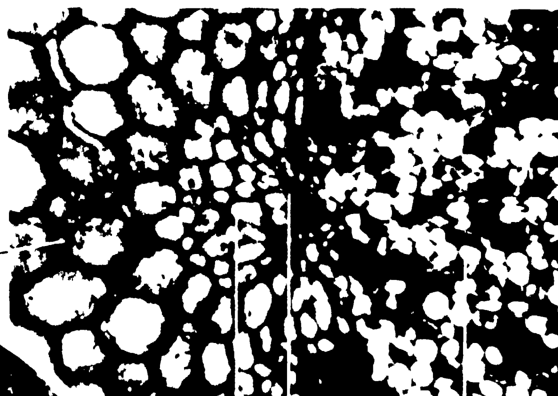

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ANDREWS—AMERICAN CARBONIFEROUS FLORAS. I

EXPLANATION OF PLATE

PLATE 4

Mesoxylon Nauertianum

Figs. 13–15. Stages in the departure of a root from the stem: fig. 13, WCB92A.1; fig. 14, WCB92A.2; fig. 15, WCB92A.3. All figures × 5.

Fig. 16. Same root as shown in preceding figures after departure from the stem; x_2, secondary xylem; *ph*, phloem; *c*, cortex; *pd*, periderm. WCB92A.4, × 20.

Fig. 17. Tangential section through the secondary wood of the stem. × 110.

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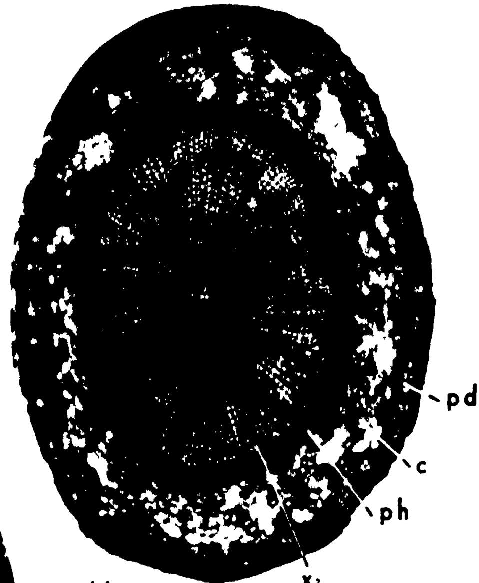

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ANDREWS—AMERICAN CARBONIFEROUS FLORAS. I

CONTRIBUTIONS TO OUR KNOWLEDGE OF AMERICAN CARBONIFEROUS FLORAS[1]

II. Lepidocarpon

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In recent investigations of the American Pennsylvanian coal-balls, no less than three new species of *Lepidocarpon* have been described in as many years (Darrah, '41; Hoskins and Cross, '41; Schopf, '38). However, much still remains to be known about this interesting and important fossil, particularly its relationships to the various other Lycopod organs that are frequently found associated with it. It is perhaps especially significant that we are able to present at this time descriptions of both a well-preserved gametophyte bearing archegonia and the microsporangiate strobilus of a *Lepidocarpon* from southern Illinois. Gametophytes have been reported for the genus but never undoubted archegonia, so far as we are aware, nor microspore-bearing organs.

Materials and Procedure.—

All of the material described below was obtained from the Pyramid Mine of the Binkley Coal Company, Perry County, Illinois. Our collections contain two species of Lycopod seeds, an *Illiniocarpon,* probably *I. Cadyi* Schopf, and the *Lepidocarpon* described here. Numerous specimens of the latter have been found but thus far we have but one in which the gametophyte is preserved. It was found in a coal-ball numbered WCB56 in our collections, and all references in this paper pertain to that specimen. Other parts of this particular seed are not as well preserved as certain of the specimens lacking a gametophyte, particularly WCB55. These two serve as the basis of the following description, although our knowledge of the species has been supplemented by numerous other specimens.

The original saw cut through WCB56 was apparently near one

[1] A study financed in part by a grant from the Penrose Fund of the American Philosophical Society.

Issued February 18, 1942.

end of the gametophyte. A ground section was prepared from one half and a series of nearly 200 peels, extending through a radial distance of about one cm., from the other half. In WCB55 a series of 170 peels, as well as some ground sections, was made in order to follow the structural changes that take place between the proximal and distal ends.

Our knowledge of the "male" strobili is based on abundant microspores which occur within the seeds and two partially complete cones bearing mature microspores *in situ*. Series of transverse and longitudinal sections were prepared through these strobili.

Inasmuch as the seeds that we refer herewith to *Lepidocarpon* are typical for the genus, it does not seem necessary to describe in detail all of the better-known features. Inclusive generic descriptions may be found in Scott's ('01) monumental treatise as well as the more recent work of Hoskins and Cross ('41) and Schopf ('41). Our descriptions will stress, rather, those points that are previously unreported or poorly understood.

The Seed.—

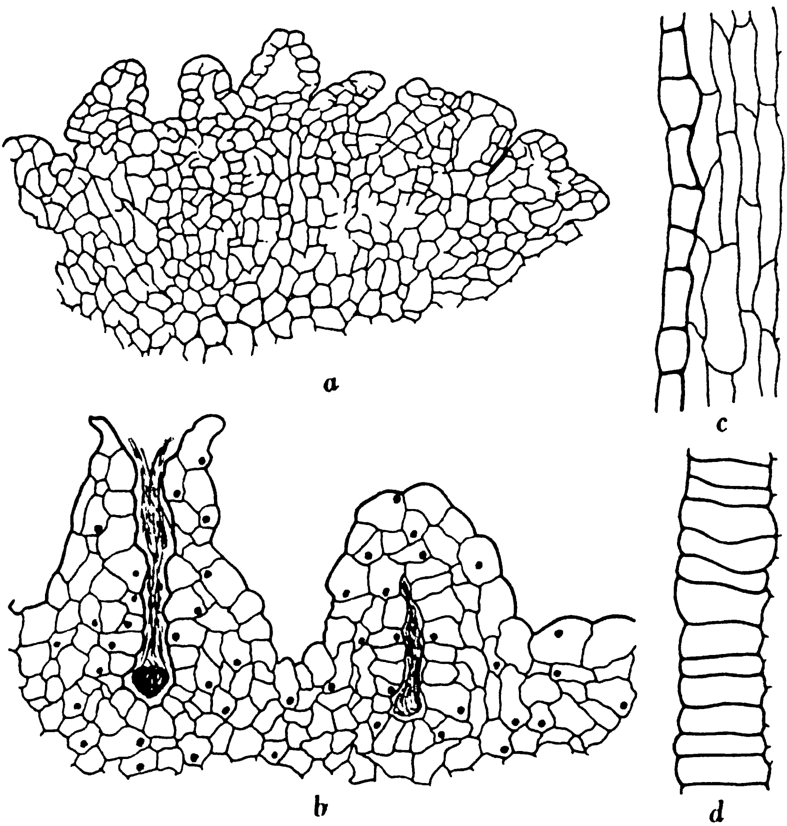
Seven preparations have been selected from the series made from specimen WCB55 to illustrate in tangential section the structure of a typical seed. These are shown in figs. 1–4, 7, 8 and 13 of pls. 5–7. Figure 1 shows the proximal end of the seed near its attachment to the axis; figs. 2 and 3 are from points approximately ¼ and 1 mm. farther out, the sporangium appearing in the former; fig. 7 is from the central region; fig. 4 is from a point midway between fig. 7 and the distal end, while figs. 8 and 13 are close to the outside.

It may be noted that the seed as a whole is comparatively narrow close to the cone axis and gradually broadens, the base becoming extremely massive toward the distal end. An interesting feature appears in fig. 8 where two loops appear on either side and immediately below the vascular bundle; in fig. 13 these have united, cutting off what is, in fact, the lower (dorsal) lobe or "heel" of the sporophyll.

The cellular structure of the sporangium wall is well preserved and consists of an outer layer of comparatively thick-walled, brick-shaped cells enclosing a zone of more delicate elongate ones (text-fig. 1*c*). As will be noted on a later page, the outer mechanical cells are quite different from the corresponding tissue found in the microsporangium (text-fig. 1*d*). At either side of the base of the sporangium there is a supporting tissue of thick-walled cells following up

the sporangial wall and adjoining portion of the sporophyll for a short distance (text-fig. 2).

Although the vascular bundle is well preserved, no part of it can unhesitatingly be called protoxylem. As in *L. Lomaxi,* transfusion tissue is present at least toward the distal end (pl. 7, fig. 14). Parichnos strands, or the cavities left after the decay of the delicate



Text-fig. 1. *a, Lepidocarpon magnificum,* part of the gametophyte bearing archegonia, from slide WCB56B.12, × 65; *b,* part of the gametophyte of *Lycopodium obscurum,* from a slide in the Eames Collection, Cornell University, × 185; *c,* a portion of the megasporangium wall of *L. magnificum,* × 250; *d,* a portion of the microsporangium wall of *L. magnificum,* × 250.

tissue composing them, are present throughout the length of the sporangial region although they are much more strongly developed in the distal end (figs. 4, 8, 13, of pls. 5–7).

The Gametophyte.—

A distinctive and rather surprising feature of the gametophyte described here is its small size compared with the seed as a whole

(pl. 6, fig. 11). Although both its distal and proximal ends are poorly preserved, the more or less cylindrical form and orientation in life, as shown in fig. 12, remain constant through the series of 200 peels. Its diminutive size, which presents a contrast to other described Lycopod gametophytes, will be discussed in a later paragraph.

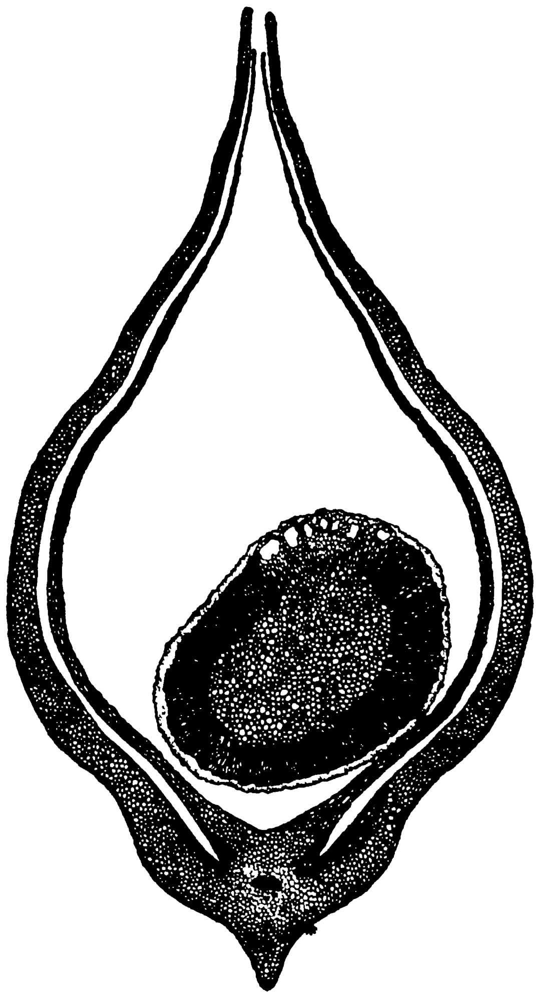
The gametophyte is composed of two distinct cellular regions as shown in fig. 12 and text-fig. 2: a central core of large isodiametric cells, averaging about 66 μ, enclosed by a zone of more or less radially aligned cells, an organization quite similar to that found in the gametophyte of certain living species of *Lycopodium.* The most striking feature of the specimen lies in the presence, on the upper side, of structures which we believe to be archegonia (pl. 6, fig. 12, *ar,* and text-fig. 2). Although the neck and venter walls do not appear to have been as generally massive in the fossil, they bear a strong resemblance to the female organs of *Lycopodium.* Camera-lucida drawings of the archegonia of both genera are presented for comparison in text-fig. 1*a* and *b.* The fine preservation of the tissue immediately adjacent to the archegonia seems to preclude the possibility that they are artifacts resulting from partial decay of the periphery of the gametophyte.

Scott described the rather well-preserved gametophytes of *Lepidocarpon Lomaxi* and *L. Wildianum,* but they differ in at least two respects from our Illinois specimen. The gametophyte of the English species fills or nearly fills the entire sporangium, while in ours it occupies a much smaller portion and the cellular differentiation into a central core and an outer peripheral region is much more pronounced in our specimens.

A few other fossil Lycopods have been reported with gametophytes, most noteworthy of which are *Lepidostrobus Veltheimianus* (Scott, '20; Gordon, '10) and *Lepidodendron esnostense* (Renault, 1896). These species are not as well preserved nor do they present points of close similarity with the one described here. Of the American Lycopod seeds described in recent years (Krick, '32; Reed, '36, '41; Schopf, '38; Darrah, '41; Hoskins and Cross, '41) in only one is the gametophytic tissue preserved. With reference to his *Lepidocarpon glabrum,* Darrah notes that "The gametophyte is extensive, nearly filling the whole cavity" (p. 99), but his description and illustrations are not sufficiently detailed to allow comparison.

The small size of our gametophyte is a feature deserving further comment. Since it is the only one that we have found, it is impossible

to state for certain whether or not it is typical. If so, then it would seem that we are dealing with a more primitive seed than previously described species, such as *L. Lomaxi,* and one in which possibly more than one megaspore was functional.



Text-fig. 2. Restoration of a seed of *Lepidocarpon magnificum,* taken approximately midway between the proximal and distal ends; from slides WCB55I.i4, WCB55II.o3, WCB56B.12, WCB56B.39.

It is not entirely improbable that certain of those fossil Lycopods which attained the seed level produced more than one embryo in each seed. Professor A. J. Eames has kindly shown the senior author single gametophytes of living species of *Lycopodium* col-

lected near Ithaca, N. Y., bearing as many as seven sporelings in an advanced stage of development.

Judging from what we know of the structure of mature specimens of *Lepidocarpon* in general, and that is now quite extensive, they were not seeds constructed to withstand long periods of adverse conditions. The survivors must have been those that were deposited in moist places favorable for growth. A hypothetical *Lepidocarpon* combining the multiple sporeling character of *Lycopodium* with the potentiality of possessing more than one functional megaspore may reasonably be postulated. Deposited, as most of them probably were, under conditions favorable to quick germination such seeds would have been exceptionally efficient, no matter how primitive from a morphological standpoint. That such an organ would encounter difficulties under more xerophytic conditions is obvious and probably accounts in large part for the decline of the arborescent forms.

The Microsporangiate Cones.—

In the earlier phases of this study microspores were observed in considerable numbers within the gametophyte-bearing seed, and further search revealed their presence in other specimens. At least four different species of spores have been found in the seeds, two of which are most likely fern spores (figs. 5, 6, of pl. 5), while other larger ones characterized by a prominent equatorial wing are referable to *Endosporites* (Wilson and Coe, '40). These are briefly mentioned for whatever ecological value they may present. The fourth and by far the most abundant (pl. 6, figs. 9, 10) are believed to be the microspores of the *Lepidocarpon* seeds for reasons that will be set forth below.

The presence of microspores within the seed is of considerable significance in the establishment of the true morphological status of the genus. With reference to the species that he described, Scott wrote ('01, p. 322):

"Unfortunately we are at present unable to decide whether pollination, in *Lepidocarpon*, took place on the parent plant or not. Microspores have not been observed within the integument of the megasporangium, nor is there anything of the nature of a pollen-chamber to receive them. We must therefore take into account the possibility that the seed-like organs of *Lepidocarpon* may have served merely for the protection of the megaspores and prothallus; that they were shed first and received the microspores afterwards. On this supposition, it is possible that all the specimens observed, including those with prothalli, were still unfertilized or even unpollinated. If this were so, the organs in question were certainly not true seeds, though it is possible that the evolution of true seeds may have started in the same way."

The abundance of microspores in our seeds renders highly improbable their presence as the result of chance entry after shedding. It seems certain that they have been deposited through a normal pollination process. We may pass now to a consideration of the microsporangiate cones themselves.

Two partially complete strobili have been obtained from the Pyramid Mine, numbered WCB166 and WCB172 in our collections. The former measures approximately 16 cm. long and in life was about 5 cm. in diameter, although only one longitudinal half is preserved. Toward one end the woody axis is complete and quite well preserved, and although most of the sporangia have dehisced a few still retain their spores. In the other specimen (WCB172) the cone is 15 cm. long by 5 cm. in diameter and runs through the entire length of the coal-ball. It was apparently somewhat longer in life.

The xylem of the cone axis measures 1.4 mm. in diameter and is siphonostelic, enclosing a central pith cavity 0.6 mm. in diameter. The pith, as well as the tissue immediately outside the xylem, is not preserved. About 34 protoxylem points are distributed about the periphery of the woody axis in an exarch position.

The structure and arrangement of the sporophylls midway between their proximal and distal ends are shown in fig. 20 of pl. 8. Like the seeds, they become massive toward the outside where parichnos strands are well developed and a ligule is present (pl. 7, fig. 16, pl. 8, fig. 18). The organization of the sporophylls is uniform throughout the length of the cone and likewise the size and form of the contained spores. In fig. 15 a part of one of the cones is illustrated in which certain sporangia have retained their spores. A portion of one of these sporangia is shown at a higher magnification in fig. 19. Two particularly significant features may be noted here: first, the columnar outer cells which are elongated at right angles to the surface (averaging $15 \times 45\ \mu$) are quite in contrast to the horizontally elongated corresponding cells in the megasporophylls (cf. text-fig. 1*c* and *d*); second, the persistence of the mature spores in tetrads. A few of the latter are shown at a higher magnification in pl. 7, fig. 17. They are uniform in size and shape and average 26 μ. If, now, these spores and those present in the seeds (figs. 9, 10) be compared (the two are illustrated at the same magnification), the very close similarity is apparent. *However, not only are they strictly comparable in size and form but, as noted above, they frequently occur in tetrads in the seeds as well as in the microspor-*

angia. The abundance of these microspores in the seeds, combined with the fact that individually they are indistinguishable from those borne in the microsporangiate cones, leaves no doubt that the latter and the *Lepidocarpon* seeds belong to the same species.

In view of the numerous previously unrecorded features characterizing our specimens it seems advisable to introduce a new specific name.

Lepidocarpon magnificum Andrews and Pannell, sp. nov.

Diagnosis.—

Seeds detached, 19–20 mm. long (parallel to sporophyll pedicel and not including free portion of lamina), approximately 6 mm. broad by 11 mm. high in the central portion; one functional megaspore occupying about one quarter of the sporangial cavity, columnar cells of sporangium wall horizontally elongated, gametophyte well developed and composed of a central mass of isodiametric cells surrounded by a broad zone of smaller, more or less radially arranged cells; apparent archegonia borne in the upper portion; microspores abundant within the sporangium; microsporangiate cones at least 16 cm. long by 5 cm. in diameter, columnar cells of sporangial wall vertically elongated, microspores 26 μ in diameter, tending to remain in tetrads when mature. Locality and horizon: Pyramid Mine of the Binkley Coal Company, 3 miles south of Pinckneyville, Illinois; coal #6, Upper Carboniferous.

Discussion.—

The microsporangiate cones that we have assigned to *Lepidocarpon magnificum* agree closely with *Lepidostrobus Coulteri* Jongmans as described by Coulter and Land ('11, '21) and Mathews ('40). It is highly probable that the latter are specifically comparable with those described here, but although we have no hesitancy in referring our own specimens to *L. magnificum* it is perhaps best to retain *Lepidostrobus Coulteri* (for Coulter and Land's specimens) until a monographic work of the group is prepared.

In his account of the English species, Scott ('01) mentions a microsporangiate cone as questionably referable to *L. Lomaxi* but due to the uncertainty involved he did not include a description of it. The supposed relationship of this cone to *Lepidocarpon* was based on "The presence of rudimentary integuments, together with agreement in details of structure and the evidence of association. . . ." [p. 314]. Further discussion of that species can be of little avail until additional collections of it are at hand.

It is clear that in the two microsporangiate cones described there is no indication of an integument enclosing the sporangia. They are mature and strictly microsporous and, in themselves, typical *Lepidostrobus* cones. However, the occurrence of the microspores in the seeds, as noted in detail above, affords sufficient evidence in our opinion for their reference to *L. magnificum.*

The only possible doubtful feature of our taxonomic treatment of the microsporangiate cones and seeds is the contrasting structure of the outer mechanical cells of their respective sporangia. It must be remembered, however, that this tissue is a highly specialized dehiscence mechanism allowing dissemination of the microspores, and likewise megaspores in forms such as *Selaginella* and *Lepidostrobus* where a true seed habit has not been reached. With the evolution of the permanent retention of a single functional megaspore the need for such a tissue diminishes, although the sporangium must of course be opened sufficiently to admit the microspores. Inasmuch as the function of the microsporangium apparently remained more nearly static during this seed development, it is logical that its structure should remain the same. For the same reason the absence of an "integument" from the microsporangium in no way invalidates the apparent relationship to the seed.

It becomes increasingly clear that the Lepidocarpaceae is a diverse group and one whose taxonomy will undergo frequent revisions in the future.

Acknowledgment.—
We are indebted to Professor A. J. Eames for his helpful criticism and for the opportunity to study his fine collection of *Lycopodium* gametophytes.

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Explanation of Plate

PLATE 5

Figs. 1–4. *Lepidocarpon magnificum.* Part of a series of peel preparations starting near the point of attachment to the cone axis and progressing toward the distal end: fig. 1, WCB55I.02; fig. 2, WCB55I.04; fig. 3, WCB55I.013; fig. 4, WCB55II.i2. All figures × 11 except fig. 4, which is × 10.

Figs. 5, 6. Foreign spores, probably of ferns, found within the seed of *Lepidocarpon:* fig. 5, WCB56B.12; fig. 6, WCB56B.41. Both figures × 700.

1 2 3

4 5 6

ANDREWS & PANNELL—AMERICAN CARBONIFEROUS FLORAS. II

Explanation of Plate

PLATE 6

Lepidocarpon magnificum

Figs. 7, 8. Part of the series shown in figs. 1–4, explanation in text: fig. 7, WCB55I.016; fig. 8, WCB55III.01. Both figures × 10.

Figs. 9, 10. Microspores found within the seed: fig. 9 shows characteristic retention of the tetrad after dispersal, WCB56B.9; fig. 10, a single spore showing triradiate commissure, WCB56B.23. Both figures × 700.

Figs. 11, 12. Photographs of the specimen bearing a gametophyte: fig. 11, from WCB56B.1, × 12; fig. 12, the gametophyte enlarged; *ar*, archegonia; *mw*, megaspore wall; from WCB56B.12, × 20.

ANDREWS & PANNELL—AMERICAN CARBONIFEROUS FLORAS. II

Explanation of Plate

PLATE 7

Lepidocarpon magnificum

Fig. 13. Tangential section near the distal end of the sporophyll shown in figs. 1–4, 7 and 8; *p*, parichnos; *i*, integument; *sp*, sporangium wall; *h*, heel of sporophyll; *v*, vascular bundle. From WCB55III.09, × 10.

Fig. 14. Enlarged bundle region of the seed, showing *v*, vascular bundle, *tc*, transfusion cells. From WCB55III.i4, × 80.

Fig. 15. Longitudinal section through part of a microsporangiate cone. Most of the sporangia have dehisced although a few retain their spores, *s*. WCB166B2.S3, × 3.1.

Fig. 16. Longitudinal section of a microsporophyll from near the distal end; *sp*, sporangium; *l*, ligule; *spf*, sporophyll. WCB172J.S16, × 12.5.

Fig. 17. A few microspores showing the characteristic retention of the tetrad. WCB166B1.S2, × 700.

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EXPLANATION OF PLATE

PLATE 8

Lepidocarpon magnificum

Fig. 18. Tangential section of part of the microsporangiate cone near the distal extremity of the sporophylls. WCB172C.S16, × 3.5.

Fig. 19. Part of a sporangium containing microspores from the specimen illustrated in fig. 15. WCB166B1.S2, × 80.

Fig. 20. Tangential section through a microsporangiate cone, taken about midway between the cone axis and distal end of the sporophylls, showing the dehisced sporangia. WCB172C2.S2, × 3.5.

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NEW GESNERIACEAE FROM PANAMA[1]

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The many botanical collections that have been made recently in Panama, chiefly under the auspices of the Missouri Botanical Garden, have added greatly to our knowledge of the family Gesneriaceae. The plants of this family are exclusively tropical and often epiphytic. Until the last few years fewer than 20 species have been known from Panama. This number has been much more than doubled. There are known now over 30 species of *Columnea* alone, more than are recorded from Costa Rica, formerly considered one of the richest regons for Gesneriaceae. Almost all the novelties belong to the subfamily Columneoideae, which reaches its greatest development in Colombia.

The greatest number of new species have been discovered by Mr. Paul H. Allen, an exceedingly discerning collector, with an unusual faculty for picking out interesting and rare plants. Most of his recent collections have come from a locality cited as "hills north of El Valle de Anton, Province of Coclé, altitude 1000 meters." This locality is described by Mr. Allen in a letter dated Feb. 2, 1941, as follows:

> "About a week ago I had the opportunity of spending four days in El Valle, in Coclé Province, and I am astonished at the tremendous wealth of the place. This time I was able to get up into the high plateau regions to the north, and never in all my collecting experience have I seen such a fantastic region or such fascinating plants. After leaving the crater proper, there is a line of buffer hills to the north, rising in three rounded domes topped with an elfin forest and over which a steady cascade of fog and misty rain pours. To the north of these hills is a maze of valleys, with a most curious set of plateaus, some not over an acre or two and others probably forty or more acres. The tops are almost perfectly flat, with deep rich black soil, supporting a growth of giant trees which literally drip with epiphytes of all descriptions. There are almost always practically sheer drops on nearly all sides of these places, sometimes going down for several hundred feet. This last time there I came to such a precipice and could look down six or seven hundred feet below to where the tumbled hills and interlocking valleys ran off to the north. Occasionally the mists would clear for a bit, and far off the Atlantic Ocean could be seen. . . . I think I can guarantee that you will get some interesting plants."

Mr. Allen was quite right. On this trip, as on several later ones, he found many new and interesting plants, especially in the Ges-

[1] Published by permission of the Secretary of the Smithsonian Institution.

Issued February 18, 1942.

neriaceae. The affinity of the flora of this region is decidedly with the mountain flora of Costa Rica.

In addition to the plants collected by Mr. Allen, I have had the advantage of studying collections made by Dr. Robert E. Woodson, Jr. and Mr. R. W. Schery. These include several novelties, here described. A small, but very interesting collection, made by Mr. and Mrs. Terry in the mountains of the Province of Darien, was kindly made available by the Field Museum of Natural History.

The present paper lists only new species and new records. A complete account of the Gesneriaceae of Panama will be published at a later date.

ALLOPLECTUS CORIACEUS (Oerst.) Hanst. Linnaea **34**: 363. 1865–66.—BOCAS DEL TORO: Cricamola, region of Almirante, Jan.–March, 1928, *Cooper 207*. Distributed as *Drymonia* sp. Previously known from Costa Rica.

ALLOPLECTUS ICHTHYODERMA var. PALLIDUS Morton, Field Mus. Publ. Bot. **18**: 1145. 1938.—CHIRIQUÍ: Casita Alta to Cerro Copete, alt. 2300–3300 m., July 10, 1940, *Woodson & Schery 359*. Previously known from Costa Rica.

ALLOPLECTUS **panamensis** Morton, sp. nov. Herba lignosa, 1 m. alta; caules non ramosi, crassi, usque ad 12 mm. diam., apice ca. 5 mm. diam., tetragoni, lateraliter compressi, dense flavo-subhirsuti; folia per paria aequalia, longe petiolata, petiolo 5–11 cm. longo, hirsuto; lamina foliorum ovata 21–23 cm. longa, 12.5–15 cm. lata, breviter acuminata, basi rotundata, aequalis, chartacea, serrulata, supra viridis, pilosa, subtus pallidior, non rubro-maculata, ubique dense pilosa, venis lateralibus ca. 8-jugis, supra subobscuris; inflorescentia axillaris, densiflora, bracteis rubris, ovatis, ca. 1.5 cm. longis, acuminatis, denticulatis, pilosis, pedicellis 2–3 cm. longis, dense hirsutis; calyx ruber, lobis subaequalibus, oblongis, ca. 2.5 cm. longis, 1 cm. latis, acutis, herbaceis, glanduloso-serratis (dentibus ca. 11 utroque latere), externe dense flavo-hirsutis, intus strigosis; corolla coccinea, 4.5–5 cm. longa, in calyce obliqua, basi calcarata (4 mm.), tubo ca. 4 mm. diam. supra basim, sursum gradatim ampliato, non ventricoso, externe dense hirsuto, intus glabro, fauce 1 cm. lato, obliquo, limbo ca. 1.5 cm. lato, obliquo, lobis recurvis, subaequalibus, suborbiculatis, ca. 4 mm. longis, subintegris, intus glabris; filamenta basi vix in tubum connata, im corolla alte adnata, glabra; antherae inclusae, cohaerentes, transverse oblongae,

ca. 2 mm. longae, 3 mm. latae; ovarium hirsutum; stylus glaber; stigma bilobum; disci glandula postica solum evoluta, magna, crassa, glabra, emarginata.—COCLÉ: hills north of El Valle de Anton, alt. 1000 m., July 14, 1940, *Paul H. Allen 2189* (U. S. Nat. Herb., no. 1,791,876-7, TYPE); same locality June 23, 1940, *Allen 2166*.

On Cerro Campana in the Province of Panamá a related species has been collected (*Allen 2412*), which at first I considered the same. However, I am sure now that it is different, but the material lacks corollas and is insufficient for a description.

Alloplectus panamensis belongs to the section Glossoloma, but is not closely related to the other North American species, *A. tetragonus* and *A. simulatus*, which have appressed pubescence on stems and leaves. They have, also, cuneate-based leaves, those of *A. panamensis* being much broader and rounded-truncate at base.

ALLOPLECTUS **simulatus** Morton, sp. nov. Herba 1–2 m. alta; caules non ramosi, tetragoni, apice ca. 3 mm. diam., appresso-puberuli; folia per paria aequalia, longe petiolata, petiolo 5.5–6 cm. longo, puberulo; lamina foliorum late elliptica, 14–17 cm. longa, 6–7.5 cm. lata, acuminata, basi late cuneata, paullo obliqua, subherbacea, serrulata, utrinque viridis et sparse puberula, pilis flavidis, flaccidis, paucicellularibus, venis lateralibus ca. 9-jugis; inflorescentia axillaris, pauciflora, bracteis deciduis, pedicellis 2–3 cm. longis, hirsutis; calyx rubro-aurantiacus, lobis subaequalibus, ovatis, 2.5–2.7 cm. longis, acutis, argute serratis, externe hirsutis, praecipue in linea mediali; corolla externe rubro-aurantiaca, intus lutea, ca. 5 cm. longa, in calyce obliqua, tubo faucem versus ampliato, densissime hirsuto, limbo valde obliquo, ca. 1.7 cm. lato, lobis subaequalibus, recurvis, intus glabris.—CHIRIQUÍ: vicinity of Bajo Mona and Quebrada Chiquero, alt. 1500 m., July 18, 1940, *R. E. Woodson & R. W. Schery 537* (U. S. Nat. Herb., no. 1, 808, 045, TYPE).

Closely related to *A. tetragonus* of Costa Rica, but differing in pubescence. In *A. tetragonus* the pubescence of the stems and lower leaf surface is closely appressed, but in *A. simulatus* the hairs are not appressed, but tortuous, very short and few-celled. In the Gesneriaceae, as a whole, the character of the hairs is very constant within the species, so this character alone would be sufficient to separate these two species. There are other differences also. The calyx of *A. simulatus* is larger and broader, the corolla more densely hirsute and the limb broader.

Besleria **Allenii** Morton, sp. nov. Frutex 1–1.5 m. altus; caules non ramosi, teretes, graciles, ca. 3 mm. diam., apicem versus 1 mm. diam., dense et breviter puberuli; folia per paria aequalia, petiolata, petiolo 0.8–4 cm. longo, gracili, puberulo; lamina foliorum oblonga, 7–13 cm. longa, 3–4.7 cm. lata, acuminata, basi late cuneata, paullo obliqua, membranacea, irregulariter serrata, supra atroviridis, glabra, subtus pallidior, praecipue in venis strigosa, venis lateralibus 10- vel 11-jugis subtus prominulis; inflorescentia axillaris, umbellata, 3- vel 4-flora, pedunculo communi ca. 2.5 cm. longo, parce pilosulo, pedicellis ca. 12 mm. longis; calyx viridis, lobis paullo inaequalibus, lobo postico ovato, reflexo, ca. 1.4 cm. longo, 7 mm. lato, lateralibus ovato-lanceolatis, obliquis, ca. 15 mm. longis et 6 mm. latis, anticis lanceolatis, ca. 15 mm. longis et 5 mm. latis, omnibus longe et acriter acuminatis, argute serratis, externe hirsutis, intus glanduloso-pilosulis; corolla flava, 3.5–4 cm. longa, in calyce horizontalis, basi postice calcarata (7 mm.), tubo basi ca. 5 mm. diam., sursum valde ventricoso, faucem versus non contracto, 1.8–2 cm. lato, externe glanduloso-pilosulo, intus glabro, limbo magno, terminali, bilabiato, lobis latis, rotundatis, intus glabris; filamenta glabra; antherae inclusae, cohaerentes, ca. 1.5 mm. longae et 2 mm. latae, loculis confluentibus; ovarium pilosulum; stylus pilosulus; stigma bilobum; discus annularis, antice evanescens, postice magnus, crassus, puberulus.—coclé: vicinity of La Mesa, north of El Valle de Anton, alt. 1000 m., May 12, 1941, *Paul H. Allen 2371* (U. S. Nat. Herb., no. 1,793,964, type).

This species belongs to section Neobesleria subsect. Wendlandianae. From *Besleria Wendlandiana* Hanst., of Costa Rica and Panama, it differs in the strongly ventricose, very broad corolla. From *B. columbiana* Morton it differs in the shorter peduncle and longer pedicels, the much larger calyx lobes, and the much larger and broader corolla.

Besleria Allenii var. **paucivenia** Morton, var. nov. A var. *typica* venis lateralibus paucioribus (7- vel 8-jugis), inflorescentia uniflora, pedunculo communi brevi (1–1.5 cm. longo), pedicellis longioribus (1.5–2 cm. longis) differt.—coclé: hills north of El Valle de Anton, alt. 1000 m., July 14, 1941, *Paul H. Allen 2188* (U. S. Nat. Herb., no. 1,806,127, type).

Besleria barbensis var. **hirsuta** Morton, var. nov. Herba 1 m. alta; caules non ramosi, ca. 3 mm. diam., apicem versus ca. 2 mm.

diam., hirsuti; folia per paria aequalia, petiolata, petiolo 2–3 cm. longo, gracili, hirsuto; lamina foliorum elliptica, 8–12 cm. longa, 4–5.5 cm. lata, breviter acuminata, basi cuneata, aequalis, herbacea, inconspicue serrulata, supra viridis, subtus pallidior, utrinque hirsuta, venis lateralibus 11- vel 12-jugis, subtus prominulis; inflorescentia axillaris, uniflora, pedunculo communi nullo, bracteis nullis, pedicello 3–3.5 cm. longo, gracili, hirsuto; calycis lobi virides, fere liberi, paullo inaequales, lobo postico ovato, ca. 12 mm. longo et 7 mm. basi lato, alteris oblongis, ca. 13 mm. longis, 5 mm. latis, omnibus acutis, argute serratis (dentibus subulatis, apice glandulosis), externe hirsutis, intus glabris; corolla aurantiaca, ca. 2 cm. longa, in calyce erecta, basi vix saccata, tubo supra basim ca. 4.5 mm. lato, sursum paullo ventricoso et 7 mm. lato, externe apice hirsuto, intus lineam horizontalem sparse pilosam gerente, limbo satis magno, ca. 12 mm. lato, terminali, bilabiato, lobis orbiculatis, patentibus, ca. 5 mm. longis et 7 mm. latis, rotundatis, subintegris, externe pilosis, intus glabris; filamenta glabra; antherae cohaerentes, inclusae, quadratae, ca. 1.5 mm. longae et 2 mm. latae, loculis confluentibus; ovarium apice pilosum; stylus pilosulus; stigma bilobum; discus annularis, integer, glaber, brevis, crassus.—CHIRIQUÍ: on the trail from Cerro Punta to headwaters of Rio Caldera, alt. 2250–2500 m., Jan. 14, 1939, *Paul H. Allen 1449* (U. S. Nat. Herb., no. 1,749,713, TYPE).

BESLERIA **crassicaulis** Morton, sp. nov. Herba 1.5–2.1 m. alta; caules crassissimi, non ramosi, ca. 11 mm. diam., apice ca. 9 mm. diam., teretes, densissime flavo-sericei; folia per paria aequalia, petiolata, petiolo 4–4.5 cm. longo, crassissimo, 5–9 mm. diam., densissime flavo-sericeo; lamina foliorum oblonga, magna, plus quam 30 cm. longa, 10 cm. lata, abrupte et breviter acuminata, basi obtusa vel late cuneata, subaequalis, integra, subcoriacea, supra viridis, glabra, subtus pallidior, praecipue in nervo mediali et venis primariis sericeo-strigosa, venis lateralibus verisimiliter ca. 12-jugis; inflorescentia axillaris, multiflora, pedunculo communi obsoleto, pedicellis numerosissimis, 12–15 mm. longis, gracilibus, subhirsutis; calycis lobi orbiculares, 5 mm. longi, 4 mm. lati, herbacei, rotundati, non mucronati, venosi, integri, externe praecipue basim versus subhirsuti, intus glabri, margine valde ciliati; corolla coccinea, ca. 17 mm. longa, in calyce paullo obliqua, basi saccata, tubo supra basim 4 mm. diam., sursum non ventricoso, 5 mm. diam., in fauce non contracto, externe glabro, intus glabro, limbo terminali,

subregulari, ca. 6 mm. lato, lobis suborbiculatis, ca. 2.5 mm. longis, subintegris, rotundatis, utrinque glabris; filamenta glabra; antherae loculi parvi, ca. 0.8 mm. longi, confluentes; ovarium fere glabrum, apice breviter pilosulum; stylus sparse pilosulus; stigma bilobum; discus annularis, glaber, brevis.—DARIEN: Cana-Cuasi Trail, Chepigana District, alt. 600 m., Mar. 12, 1940, *M. E. & R. A. Terry 1534* (Herb. Field Mus., no. 1,035,994, TYPE).

A species recalling the Colombian *Besleria maxima* Morton and *B. tambensis* Morton in its large leaves, very thick, densely hairy stem, and congested inflorescences. However, *B. crassicaulis* is probably not closely allied to either, but rather to *B. notabilis* Morton of Costa Rica, which has smaller, oblong calyx lobes only 3 mm. long and 1.5 mm. wide, and a smaller unspurred corolla.

BESLERIA **obliqua** Morton, sp. nov. Frutex 2 m. altus; caules ramosi, teretes, ca. 5 mm. diam., apicem versus ca. 2 mm. diam., breviter et dense scabro-pilosuli; folia per paria subaequalia, petiolo 1–2 cm. longo, scabro-pilosulo; lamina foliorum lanceolata, 4–7 cm. longa, 1.2–2.1 cm. lata, acuminata, basi cuneata, subaequalis, integra, chartacea, supra viridis, scabra (pilis patulis, basi valde inflatis), subtus pallidior, ubique pilosula, venis lateralibus 6-jugis; inflorescentia axillaris, pauciflora, pedunculo communi obsoleto, pedicellis ca. 5 mm. longis, pilosulis; calyx viridis, quam corolla multo brevior, lobis ovatis, paullo inaequalibus, postico ca. 2.5 mm. longo et lato, alteris ca. 3 mm. longis et 2 mm. latis, omnibus fere liberis, obtusis, non mucronatis, non venosis, externe pilosulis, intus glabris; corolla aurantiaca, ca. 17 mm. longa, in calyce subhorizontalis, basi subcalcarata (2 mm.), tubo supra basim ca. 4 mm. diam., sursum tubuloso, non ventricoso, externe sparse pilosulo, intus basi glabro, sursum glanduloso-pilosulo, in fauce non vel vix contracto, ca. 5 mm. lato, limbo terminali, ca. 7 mm. lato, lobis suborbiculatis, subaequalibus, ca. 3 mm. longis et latis, utrinque glabris, integris, rotundatis; filamenta basi in tubum antice ca. 3 mm. longum connata, glabra, partibus liberis brevibus, ca. 4 mm. longis, glabris; antherae liberae, inclusae, parvae, ca. 0.7 mm. longae, loculis divergentibus, apice confluentibus; staminodium magnum, ca. 4 mm. longum, antheram sterilem gerens; ovarium pilosulum; stylus pilosulus, brevis; stigma paullo bilobum; discus annularis, glaber, antice brevior.—COCLÉ: vicinity of La Mesa, north of El Valle de Anton, alt. 1000 m., May 12, 1941, *Paul H. Allen 2396* (U. S. Nat. Herb., no. 1,793,974, TYPE).

This species is most closely related, perhaps, to *B. miniata* Morton, and, like that, will key out to section Neobesleria subsect. Axillares in my "Revision of Besleria."[1] I think, however, that these two species, and perhaps also *B. flava* Morton, are best referred to Eubesleria sect. Sessiles. From *B. miniata* of Ecuador the present species differs strongly in pubescence, the leaves in that species being glabrous above and merely strigillose on the veins beneath. In *B. obliqua* the leaves are densely scabro-pilose above, the hairs being very strongly inflated at base, and are spreading-pilosulous all over the lower surface.

The only Central American species with which *B. obliqua* could be confused is *B. solanoides* H.B.K., but that also has leaves nearly glabrous above and merely strigose beneath, and the corolla is erect and not horizontal in the calyx.

Campanea chiriquana Morton, Ann. Mo. Bot. Gard. **26**: 310. 1939.—chiriquí: Valley of Río Chiriquí Viejo, near Monte Lirio, Apr. 3, 1938, *Gene White 62.* Previously known only from the type.

Campanea Humboldtii (Kl.) Oerst. Centralamer. Gesner. 34. 1858.—chiriquí: Valley of Upper Río Chiriquí Viejo, alt. 1300–1900 m., July 17, 1937, *Peggy & Gene White 20;* vicinity of Bajo Chorro, alt. 1900 m., July 20–22, 1940, *Woodson & Schery 656.* Originally collected in Veraguas, Panama, but not again collected in Panama until recently.

Centrosolenia **lineata** Morton, sp. nov. Herba epiphytica, subcaulis; caudex brevis, crassissimus, ramosus, albidus, glaber; folia petiolata, numerosa, conferta, petiolo usque ad 5 cm. longo, crassissimo, basi parce pilosulo, sursum glabro; lamina foliorum suboblanceolata, 14–24 cm. longa, 3.8–6.8 cm. lata, apice longe acuminata, basi longe cuneata, decurrens, remote denticulata, supra viridis, subtus siccitate brunnea, utrinque glaberrima, venis lateralibus 9-jugis, venis secondariis obscuris; flores axillares, fasciculati, numerosi, pedicellis 6–12 mm. longis, gracilibus, glabris; calycis lobi rubro-brunnei, liberi, subulati, filiformi-attenuati, basi 1.5–2 mm. lati, medio 0.2–0.5 mm. lati, inaequales, anteriores ca. 18 mm. longi, posticus reflexus, ca. 13 mm. longus, omnes externe parce strigillosi, apicem versus ciliati; corolla alba, externe et intus rubrobrunneo-lineata, 4 cm. longa, in calyce horizontalis, basi calcarata (2 mm.), tubo basi ca. 3 mm. diam., gradatim ampliato, subinfundi-

[1] Contr. U. S. Nat. Herb. 26: 404. 1939.

buliformi, non ventricoso, in fauce non contracto, ca. 15 mm. lato, externe glabro, intus glanduloso-pilosulo, limbo bilabiato, ca. 2 cm. lato, lobis albis, patentibus, lobo antico majore, orbiculato, ca. 1 cm. longo, rotundato, externe glabro, intus valde pilosulo, glanduloso-ciliato, lobis alteris subaequalibus, minoribus, ca. 5 mm. longis, utrinque glabris, glanduloso-ciliatis; filamenta basi im corollae tubo adnata, per paria connata, glabra, apice incurva; antherae glabrae, non barbatae, inclusae, connatae, subquadratae, ca. 1.2 mm. longae et 1.5 mm. latae, connectivo crasso, loculis discretis, divergentibus; ovarium pilosum; stylus crassus, glanduloso-pilosulus; stigma stomatomorphum; disci glandula postica solum evoluta, magna, crassa, glabra, integra.—COCLÉ: hills on trail to La Mesa, north of El Valle de Anton, alt. 1000 m., Aug. 31, 1941, *Paul H. Allen 2717* (U. S. Nat. Herb., no. 1,821,127, TYPE).

In habit somewhat similar to *Centrosolenia decurrens* Morton, of Costa Rica, which may be distinguished by the following key. The genus *Centrosolenia* is new to Panama.

Corolla tube ventricose at middle; anthers bearded at apex; leaves strigose on both surfaces, hirsute on veins beneath .... *C. decurrens*

Corolla tube infundibuliform, gradually widened to throat; anthers glabrous; leaves entirely glabrous .... *C. lineata*

COLUMNEA **Allenii** Morton, sp. nov. Planta epiphytica, pendens; caules vix ramosi, graciles, ca. 1.5 mm. diam., parce strigosi; folia aequalia, breviter petiolata, petiolo ca. 3 mm. longo, strigoso; lamina foliorum oblongo-elliptica, usque ad 2 cm. longa et 1.1 cm. lata, breviter acuminata, basi rotundata, haud obliqua, integra, crassa, utrinque glabra, venis utrinque immersis, obscuris; flores axillares, solitarii, ebracteati, pedunculo 1.7–2 cm. longo, rubro-strigoso, pilis multicellularibus, flaccidis; calyx erectus, rubro-tinctus, lobis paullo inaequalibus, 2.2–3 cm. longis, ca. 1 cm. basim versus latis, longe et acriter acuminatis, integris, externe vix strigillosis, ciliatis, intus basim versus longe hirsutis; corolla coccinea, in calyce erecta, 6.8–7.5 cm. longa, basi subcalcarata (3 mm.), tubo calycem aequante, supra basim 4 mm. diam., sursum ampliato, fauce ca. 15 mm. lato, externe parce piloso, limbo valde bilabiato, galea 4–4.5 cm. longa, ca. 2.5 cm. lata, apice truncata, lobis lateralibus cum galea alte connatis, ca. 14 mm. longis, lobo inferiore reflexo, oblongo-oblanceolato, 2.7–3 cm. longo, 7–8 mm. lato; filamenta basi in tubum 4 mm. longum postice fissum connata, glabra; antherae exsertae, per paria connatae, oblongae, ca. 3 mm. longae, 1 mm. latae; ovarium

albo-pilosum; stylus pilosulus; stigma bilobum.—COCLÉ: hills north of El Valle de Anton, alt. 1000 m., June 23, 1940, *Paul H. Allen, 2179* (U. S. Nat. Herb., nos. 1,791,874–5, TYPE).

COLUMNEA **arguta** Morton, sp. nov. Planta epiphytica; caules pendentes, elongati, graciles, ca. 1.5 mm. diam., hornotini rubro-hispidi, pilis rigidis, patentibus; folia aequalia, brevissime petiolata, petiolo ca. 1 mm. longo, hispido; lamina foliorum lanceolata, 1.6–2 cm. longa, 6–7 mm. lata, longe acuminata, basi rotundata, paullo obliqua, exauriculata, non amplexicaulis, crassa, integra, utrinque glabra, margine ciliata excepta, supra viridis, subtus rubescens, venis lateralibus 1- vel 2-jugis, obscuris; flores verisimiliter solitarii, breve pedunculati, pedunculo crasso, hispido; calyx erectus, lobis subaequalibus, ca. 15 mm. longis, 9 mm. latis (dentibus inclusis), utrinque hirsutis, laciniatis (dentibus elongatis, usque ad 3 mm. longis et 1 mm. latis, ca. 5 utroque latere); corolla in calyce erecta, rubra, fauce luteo-lineata, ca. 6 cm. longa, basi subcalcarata (3 mm.), tubo supra basim 4 mm. diam., sursum paullo ampliato, ca. 1 cm. lato, externe sparse piloso, intus basi glanduloso, limbo bilabiato, intus glabro, galea 2 cm. longa, apice truncata, latissima, ca. 2.7 cm. lata, lobis lateralibus magnis, ca. 13 mm. longis, lobo inferiore elliptico, reflexo, ca. 2 cm. longo et 1.1 cm. lato, rotundato; filamenta in tubum 4 mm. longum postice fissum connata, glandulosa, sursum glabra; antherae ignotae; ovarium sericeum; stylus sparse pilosulus; stigma truncatum; disci glandula postica solum evoluta, glabra, crassa, bidenticulata.—COCLÉ: hills north of El Valle de Anton, vicinity of La Mesa, alt. 1000 m., Jan. 21, 1941, *Paul H. Allen 2336* (U. S. Nat. Herb., no. 1,806,120, TYPE).

The form of the corolla is unusual in the subgenus Eucolumnea. The galea is short and very broad, the lateral lobes large, and the lower lobes very much broader than in the other species. The corolla approaches that of section Pentadenia, but it is not ventricose or curved. It differs also from the Panama species of Pentadenia in its glabrous leaves.

The closest relationship is apparently with *Columnea flaccida* Seem. (Bot. Voy. Herald 186. 1852–57), originally described from near Gualaca, Veraguas, Panama, which has been collected a few times in Costa Rica but not since found in Panama. It is a pendent epiphyte, flowering while leafless, with stems sparingly strigose (rather than coarsely hispid as in *C. arguta)*, and corolla with a shape characteristic of Eucolumnea.

COLUMNEA **citrina** Morton, sp. nov. Planta terrestris; caulis ca. 60 cm. longus, non ramosus, basi ca. 8 mm. diam., apice 3 mm. diam., juventute strigosus; folia per paria valde inaequalia, majora oblongo-linearia, 20–25 cm. longa et 5 cm. lata, falcata, sessilia, longe acuminata, basi inferiore auriculata, semiamplexicaulia, superiore cuneata, crassa, supra glabra, viridia, subtus substrigosa, pallidiora, ca. 6 cm. infra apicem maculam rubram ca. 8 mm. longam gerentia; folia minora stipuliformia, sessilia, lineari-lanceolata, ca. 2 cm. longa et 5 mm. lata, longe acuminata, basi valde obliqua, basi inferiore auriculata et amplexicaulia, superiore rotundata; inflorescentia axillaris, biflora, bibracteata, bracteis flavis, basalibus, lineari-lanceolatis, ca. 1.5 cm. longis et 5 mm. latis, longe acuminatis, externe strigosis, intus glabris, pedunculis crassis, 1–1.5 cm. longis, dense strigosis; calyx pallide viridi-luteus, in anthesin ca. 3 cm. longus, demum 3.8 cm. longus, lobis aequalibus, erectis, lanceolatis, liberis, ca. 12 mm. latis, longe et acriter acuminatis, integris, externe substrigosis, intus glabris, linea mediali excepta; corolla lutea, intus roseo-lineata, ca. 4.7 cm. longa, in calyce erecta, basi subcalcarata (ca. 2 mm.), tubo 3 mm. super basi 5 mm. diam., sursum ventricoso et 1 cm. diam., apicem versus paullo contracto, fauce tubuloso, externe valde hirsuto, limbo valde bilabiato, fauce et lobis intus glabris, galea 2.5 cm. longa, apice alte biloba (ca. 7 mm.), lobis lateralibus cum galea alte connatis, ca. 12 mm. longis, lobo inferiore reflexo, lineari-oblongo, 18 mm. longo, 5 mm. lato; filamenta basi in tubum 4 mm. longum connata, glabra; antherae exsertae, 3 mm. longae et 2.5 mm. latae; staminodium subulatum, 3 mm. longum; ovarium dense albo-sericeum; stylus glaber; stigma stomatomorphum; disci glandula postica solum evoluta, magna, crassa, glabra, subintegra; placentae lamellae intus solum ovuliferae.—PANAMÁ: Cerro Campana, alt. 1000 m., April 21, 1941, *Paul H. Allen 2404* (U. S. Nat. Herb., nos. 1,793,913–4, TYPE).

For discussion, see under *C. rubra*.

COLUMNEA **conferta** Morton, sp. nov. Frutex epiphyticus, 0.6–1.2 m. altus; caules non ramosi, crassi, ca. 7 mm. diam., strigosi, mox glabri; folia apice conferta, per paria valde inaequalia, subsessilia, petiolo usque ad 4 mm. longo, crasso, strigoso; lamina foliorum majorum oblanceolata, subfalcata, 28–32 cm. longa, 6.5–7 cm. lata, apice breviter acuminata, basi valde obliqua, non amplexicaulis, chartacea, remote serrulata, supra viridis, glabra, subtus sparse strigosa, ca. 7 cm. infra apicem maculas 2 rubras gerens, venis

lateralibus 10–12-jugis; folia minora stipuliformia, decidua; inflorescentia axillaris, pauciflora, bracteis linearibus, ca. 2.5 cm. longis, 8 mm. latis, longe acuminatis, breviter petiolatis, integris, viridibus, pedunculis ca. 9 mm. longis, dense strigosis; calycis lobi pallidi, subaequales, ovati, ca. 2.3 cm. longi, basim versus ca. 1 cm. lati, longe et acriter acuminati, glanduloso-serrati (dentibus minutis ca. 10 utroque latere), externe substrigosi, intus fere glabri; corolla lutea, intus postice rubro-lineata, ca. 4 cm. longa, in calyce erecta, basi parum saccata, tubo supra basim paullo contracto et 3 mm. diam., sursum ampliato, non ventricoso, ca. 9 mm. diam., externe sparse glanduloso-piloso, intus glabro, fauce vix contracto, limbo obliquo, verisimiliter paullo bilabiato, lobis subaequalibus, ca. 6 mm. longis, intus glabris; filamenta basi in tubum 3.2 mm. longum postice fissum connata, glabra; antherae inclusae, cohaerentes, quadratae, ca. 1.8 mm. longae et latae; ovarium sparse pilosum; stylus glaber; stigma stomatomorphum, glabrum; disci glandula postica solum evoluta, magna, crassa, glabra, non denticulata.—DARIEN: in rain forest, on crest of Cana-Cuasi Trail, Chepigana District, alt. 1650 m., Mar. 15, 1940, *M. E. & R. A. Terry 1554* (Herb. Field Mus., no. 1,035,985, TYPE).

Perhaps related to *Columnea crassa*, but the leaves are larger and much thinner, the stems are not densely hirsute, but strigose or glabrate, and the calyx lobes are not hirsute.

COLUMNEA CONSANGUINEA Hanst. Linnaea **34**: 383. 1865–66.—CHIRIQUÍ: Bajo Chorro, alt. 1900 m., July 20–22, 1940, *Woodson & Schery 651.* Previously known from Costa Rica.

COLUMNEA **crassa** Morton, sp. nov. Planta epiphytica; caules erecti, crassi, 75 cm. longi, ca. 1 cm. diam., apice paullo angustiores, dense brunneo-hirsuti, pilis tenuibus, patentibus, multicellularibus; folia per paria inaequalia, petiolata, petiolo ca. 8 mm. longo, crassissimo, dense hirsuto; lamina foliorum majorum anguste oblanceolata, subfalcata, integra, usque ad 21 cm. longa et 5 cm. lata, longe acuminata, basi valde obliqua, crassa, supra viridis, glabra, subtus viridis, maculas rubras (saepe 2) 5–6 cm. infra apicem gerens, ubique subdense flavo-strigosa, venis primariis ca. 8-jugis; folia minora stipuliformia, sessilia, anguste lanceolata, ca. 2.5 cm. longa, ca. 8 mm. lata, basi inferiore auriculata et amplexicaulia, viridia, supra glabra, subtus strigosa; inflorescentia axillaris, uniflora?, floribus sessilibus; calyx flavus?, lobis erectis, paullo inaequalibus,

1.6–2 cm. longis, 4–7 mm. latis, glanduloso-serratis (dentibus numerosis), acuminatis, externe appresso-hirsutis, intus subglabris, linea mediali subhirsutis; corolla ignota; disci glandula postica solum evoluta; placentae lamellae intus solum ovuliferae.—PANAMÁ: Cerro Campana, alt. 1000 m., Apr. 21, 1941, *Paul H. Allen 2423* (U. S. Nat. Herb., nos. 1,793,929–30, TYPE).

Related to *C. consanguinea* Hanst. (Linnaea **34**: 383. 1865–6), of the section Collandra, which may be distinguished as follows:

Leaves lacking red spots beneath; calyx lobes entire.................. *C. consanguinea*
Leaves with 2 or more red spots beneath about a third from the apex; calyx lobes serrate.. *C. crassa*

COLUMNEA **dariensis** Morton, sp. nov. Frutex, 1.5–4.5 m. altus; caules vix ramosi, articulati, internodiis brevibus, dense strigosi, apice ca. 3 mm. diam.; folia per paria valde inaequalia, majora petiolata, petiolo 10–14 mm. longo, strigoso; lamina foliorum majorum oblanceolata, 16–23 cm. longa, 4–5.5 cm. lata, acuminata, basi obliqua, late cuneata, non amplexicaulis, integra, chartacea, supra viridis, glabra, subtus pallidior, non rubro-maculata, strigosa (praecipue in venis), venis lateralibus 7-jugis, supra obscuris; folia minora stipuliformia, minuta, decidua, lanceolata, acuminata, supra glabra, subtus strigosa; inflorescentia axillaris, pauciflora, bracteis basalibus ovatis, ca. 1.7 cm. longis, integris, acuminatis, fortasse rubris, pedicellis ca. 5 mm. longis, crassis, strigosis; calyx verisimiliter ruber, lobis subaequalibus, lanceolatis, ca. 1.7 cm. longis, 5 mm. latis, acuminatis, glanduloso-serrulatis (dentibus ca. 7 utroque latere), externe nervo mediali et marginibus strigosis, intus glabris; corolla coccineo-aurantiaca, 2.4 cm. longa, in calyce erecta, tubulosa, tubo basi ca. 3 mm. diam., sursum paullo ventricoso et 5 mm. lato, faucem versus paullo contracto et 4.5 mm. lato, externe dense flavo-strigoso, limbo parvo, vix bilabiato, ca. 5 mm. lato, lobis erectis, suborbiculatis, rotundatis, 3 inferioribus ca. 1 mm. longis, 2 superioribus ca. 2 mm. longis, altius connatis; filamenta basi in tubum brevem connata, glabra; antherae quadratae, ca. 1.5 mm. longae et latae; ovarium apice strigosum; stylus glaber; disci glandula postica solum evoluta, crassa, glabra, tridenticulata.—DARIEN: Cerro de Garagará, Sambú Basin, alt. 500–974 m., Feb. 7, 1912, *H. Pittier 5660* (U. S. Nat. Herb., no. 715,942, TYPE); rain forest on the crest of the Cana-Cuasi Trail, Chepigana District, alt. 1650 m., Mar. 13, 1940, *M. E. & R. A. Terry 1547* (Herb. Field Mus.).

From *Columnea crassa* this species differs in its much narrower

calyx lobes, strigose rather than hirsute stems, and absence of red spots on the lower leaf surface. It is probably more closely related to *C. consanguinea,* from which it differs in the serrate rather than entire calyx lobes, broader bracts, and absence of red spots on the leaves. *Columnea conferta* has a differently shaped corolla limb with much larger, broader, more oblique lobes, as well as larger, thinner, differently shaped, red-spotted leaves.

Columnea **dissimilis** Morton, sp. nov. Planta epiphytica; rami usque ad 1 m. longi, internodiis brevibus, juniores rubri, hispidi, pilis patentibus, rubris, multicellularibus; folia per paria inaequalia, petiolata, petiolo 5–9 mm. longo, hispido; lamina foliorum majorum elliptico-oblonga, usque ad 7 cm. longa et 3 cm. lata, apice acuminata, basi valde obliqua (latere inferiore rotundato, superiore cuneato), integra, utrinque viridis, supra pilosula, subtus praecipue in venis rubro-hirsuta; folia minora saepe subsessilia, ovata vel suborbicularia, acuta vel obtusa, basi rotundata, usque ad 3 cm. longa et 1.8 cm. lata; flores saepe 3 in axillis aggregati, pedunculati, pedunculo 1–1.7 cm. longo, dense longe rubro-hirsuto; calyx ruber, erectus, lobis aequalibus, liberis, lanceolatis, 2.5–3 cm. longis, acuminatis, remote glanduloso-denticulatis, herbaceis, utrinque rubro-hirsutis; corolla rubra, in calyce paullo obliqua, 3.5–4 cm. longa, basi postice subcalcarata, tubo basi 4 mm. lato, tubuloso, vix ampliato, non ventricoso, externe dense rubro-hirsuto, intus glabro, fauce 8 mm. lato, non contracto, lobis 5 aequalibus, incurvatis, ovatis, vix acutis, ca. 4.5 mm. longis, crassis, intus glabris, inter lobos appendiculata, appendiculis patentibus, lineari-subulatis, ca. 7 mm. longis, dense hirsutis; filamenta basi in tubum 4 mm. longum postice fissum connata, sursum libera, gracilia, glabra; antherae quadratae, ca. 2 mm. longae et latae; ovarium albo-pilosum; stylus gracilis, glaber; stigma bilobum; disci glandula postica solum evoluta, lata, crassa, glabra, tridenticulata.—COCLÉ: trail to Las Minas, north of El Valle de Anton, alt. 1000 m., May 10, 1941, *Paul H. Allen 2483* (U. S. Nat. Herb., no. 1,808,614, TYPE); same locality, June 23, 1940, *Allen 2164,* and July 14, 1940, *Allen 2191;* PANAMÁ: hills above Campana, alt. 600–800 m., July 1, 1939, *Allen 1875.*

Columnea **hirsutissima** Morton, sp. nov. Planta epiphytica; caules 13–30 cm. longi, non ramosi, crassi, perspicue rubro-hirsutissimi, pilis multicellularibus, ca. 5 mm. longis; folia per paria valde inaequalia, subsessilia, petiolo crasso, 1–2 mm. longo, hirsuto;

lamina foliorum majorum oblonga vel anguste oblonga, 6–10 cm. longa, 1.7–3.5 cm. lata, acuta, basi rotundata vel subcordata, non obliqua, paullo crenulata vel serrulata, utrinque viridis, non rubromaculata, dense hirsuta, pilis rubescentibus, multicellularibus, 7–9-jugis; folia minora sessilia, ovata, ca. 1 cm. longa, decidua; flores solitarii, axillares, ebracteati, pedunculati, pedunculo 8–12 mm. longo, dense hirsuto; calyx erectus, lobis subaequalibus, 1.7–1.8 cm. longis, linearibus, ca. 2.5 mm. basim versus latis, longe acuminatis, remote glanduloso-denticulatis (dentibus 2 vel 3 utroque latere), utrinque hirsutis, pilis saepe rubris; corolla rubra, in calyce erecta, 6–7.5 cm. longa, basi subcalcarata, tubo supra basim ca. 4 mm. lato, sursum tubuloso et gradatim ampliato, non ventricoso, externe sparse piloso (pilis multicellularibus non glandulosis), intus glanduloso, fauce ca. 8–9 mm. lato, limbo valde bilabiato, intus pilosulo, galea 2.3–2.5 cm. longa, apice truncata, 1.4 cm. lata, lobis lateralibus cum galea alte connatis, brevibus, ca. 6 mm. longis, lobo inferiore reflexo, lineari-oblongo, ca. 13 mm. longo, 3 mm. lato, obtuso; filamenta basi in tubum 4 mm. longum postice fissum connata, basim versus glandulosa, sursum glabra; antherae connatae, exsertae, oblongae, ca. 2 mm. longae, 1 mm. latae; ovarium albopilosum; stylus dense glanduloso-pilosulus; stigma bilobum; disci glandula postica solum evoluta, glabra, crassa, tridenticulata.—COCLÉ: hills north of El Valle de Anton, alt. 800–1000 m., Jan. 2, 1941, *Paul H. Allen 2288* (U. S. Nat. Herb., no. 1,806,116, TYPE); same locality, Nov. 21, 1940, *Allen 2279 (Dorothy Allen)*, Jan. 21, 1941, *Allen 2311* and *2348*.

For relationships, see under *C. rubra* below.

COLUMNEA **incarnata** Morton, sp. nov. Frutex epiphyticus; caules vix ramosi, sulcati, apice ca. 3 mm. diam., flavo-strigosi, demum glabrescentes; folia per paria subaequalia, petiolata, petiolo 1.3–2.3 cm. longo, strigoso; lamina foliorum oblanceolata, 7–12 cm. longa, 2.3–4 cm. lata, longe acuminata, basi aequalis, cuneata, integra, subcrassa, supra viridis, glabra, subtus pallidior, non rubromaculata, in margine et venis strigosa, venis lateralibus 4- vel 5-jugis, supra obscuris; inflorescentia axillaris, floribus solitariis vel binis, bracteis basalibus lineari-subulatis, ca. 7 mm. longis, basi ca. 1.5 mm. latis, acuminatis, intus glabris, externe strigosis, integris, pedicellis cernuis, 3–4 cm. longis, dense flavo-strigosis; calycis lobi virides, ovati, 3.3–3.5 cm. longi, ca. 1.5 cm. lati, longe et acriter acuminati, fere integri, remote glanduloso-denticulati, utrinque

glabri, parce ciliati; corolla incarnata, 6.5–7 cm. longa, in calyce erecta, basi subsaccata, tubo supra basim 5 mm. diam., abrupte ventricoso, ca. 2 cm. longo, in calyce incluso, externe puberulo, intus glanduloso, limbo curvato, valde obliquo, bilabiato, galea ca. 5 cm. longa, apice truncata, ca. 3.5 cm. lata, lobis lateralibus cum galea alte connatis, magnis, partibus liberis ca. 2.3 cm. longis, 1.3 cm. latis, rotundatis, lobo inferiore patente, magno, ca. 3 cm. longo et 1.1 cm. lato, lobis externe pilosis, intus glabris; filamenta basi in tubum 2 mm. longum postice fissum connata, dense glanduloso-puberula; antherae exsertae, cohaerentes, oblongae, 3 mm. longae et 1 mm. latae; ovarium albo-sericeum, apice pilosum; stylus glaber; stigma bilobum; disci glandula postica solum evoluta, magna, crassa, glabra, emarginata.—CHIRIQUÍ: vicinity of Bajo Chorro, alt. 1900 m., July 20–22, 1940, *R. E. Woodson & R. W. Schery 608* (Herb. Missouri Bot. Gard., TYPE).

This species belongs to the section Pentadenia and is perhaps related remotely to *C. magnifica*, which also has the disk reduced to a single posterior gland, in contrast to most of the other species of Pentadenia. It may be distinguished as follows:

Flowers pink; calyx glabrous, the lobes ciliate, subentire or remotely glandular-denticulate .... *C. incarnata*
Flowers bright scarlet; calyx villous, the lobes conspicuously dentate ...... *C. magnifica*

COLUMNEA LOCALIS Morton, Field Mus. Publ. Bot. **18**: 1165. 1938 (*Columnea microcalyx* var. *macrophylla* Donn. Smith, Bot. Gaz. **31**: 118. 1901, non *C. macrophylla* Kuntze).—This species has been known only from the type, collected in forests of Las Vueltas, Tucurrique, Costa Rica. It may now be reported from: PANAMA: Cerro de Garagará, Sambú Basin, southern Darien, alt. 500–974 m., Feb. 7, 1912, *Pittier 5625;* and CHIRIQUÍ: trail from Cerro Punta to headwaters of Río Caldera, alt. 2250–2500 m., Jan. 14, 1939, *Allen 1428*.

In the 'Flora of Costa Rica' on page 1162, in the key to *Columnea*, the name *C. microphylla* is printed *C. macrophylla*, by an unfortunate typographical error.

COLUMNEA **obliqua** Morton, sp. nov. Planta epiphytica; caules elongati, pendentes, non ramosi, straminei, teretes, ca. 2.5 mm. diam., parce flavo-strigosi, mox glabri; folia opposita, aequalia, subsessilia, lanceolata, usque ad 3.5 cm. longa et 1.2 cm. lata, apice longe acuminata, basi valde obliqua, rotundata, integra, crassa, supra viridia, subtus pallidiora et rubescentia, supra glabra, subtus in margine et venis strigosa; flores solitarii, axillares, pedunculo 7–15

mm. longo, 1 mm. crasso, substrigoso, apice paullo incrassato; calyx viridis, 1.2–1.8 cm. longus, lobis erectis, aequalibus, liberis, basi ca. 6 mm. latis, subcordatis, gradatim angustatis, longissime et acriter acuminatis, integris, externe parce strigosis, intus glabris, basi pilosula excepta; corolla aurantiaca, 6.5–8 cm. longa, in calyce erecta, basi postice paullo calcarata (1.5 mm.), tubo 3.7 mm. diam., sursum parce ampliato, non ventricoso, fauce ca. 12 mm. lato, externe parce pilosulo, intus glabro, limbo valde obliquo, bilabiato, galea erecta, integra, 3.3–3.8 cm. longa, lobis lateralibus cum galea alte connatis, ca. 1.3 cm. longis, lobo inferiore reflexo, lineari-oblongo, 1.4–1.7 cm. longo; filamenta basi in tubum 2 mm. longum postice fissum connata, sursum omnino libera, didynama, glabra, antheris oblongis, 1.6 mm. longis et 1 mm. latis, per paria connatis; ovarium albo-sericeum; stylus gracilis, parce pilosulus; stigma bilobum; disci glandula postica lata, magna, emarginata, crassa, glabra, antica parva, lineari-subulata.—CHIRIQUÍ: vicinity of Bajo Chorro, alt. 1900 m., July 20–22, 1940, *R. E. Woodson, Jr. & R. W. Schery 607* (U. S. Nat. Herb., no. 1,808,050, TYPE); same locality and date, *Woodson & Schery 677.*

COLUMNEA PANAMENSIS Morton, Ann. Mo. Bot. Gard. **26**: 312. 1939.—CHIRIQUÍ: vicinity of Finca Lérida, alt. 1750 m., July 7–11, 1940, *Woodson & Schery 235.* Previously known only from type.

COLUMNEA **pectinata** Morton, sp. nov. Planta epiphytica; caules pendentes, 100 cm. longi, rugosi, ca. 8 mm. diam., hornotini griseo-hirsuti; folia per paria inaequalia, subsessilia, petiolo vix 2 mm. longo, hirsuto; lamina foliorum majorum oblongo-falcata, usque ad 13 cm. longa et 5 cm. lata, abrupte acuminata, basi valde obliqua, basi inferiore subauriculata, crassa, apicem versus argute serrulata, supra viridis, hirsuta, subtus pallidior, apice sanguinea, ubique dense hirsuta, venis lateralibus 8–10-jugis; folia minora stipuliformia, sessilia, lanceolata, ca. 1.7 cm. longa, hirsuta, basi inferiore auriculata; inflorescentia axillaris, pluriflora, floribus breve pedunculatis, pedunculo crasso, ca. 5 mm. longo, hirsuto; calyx ruber, erectus, lobis subaequalibus, ca. 15 mm. longis, ca. 3 mm. latis, pectinato-fimbriatis (dentibus 5–6 utroque latere, subulatis, usque ad 4 mm. longis), utrinque dense hirsutis, pilis hyalinis, multicellularibus, capitato-glandulosis; corolla aurantiaca, in calyce erecta, e calyce vix exserta, ca. 1.7 cm. longa, basi subcalcarata, tubo supra basim ca. 4.5 mm. diam., sursum paullo ventricoso et 6.5 mm. diam., in fauce paullo contracto et 5 mm. diam., externe albo-piloso,

limbo regulari, haud bilabiato, 7 mm. lato, lobis patentibus, suborbiculatis, ca. 3 mm. longis, rotundatis, intus glabris; filamenta in tubum 5 mm. longum postice fissum connata, glabra, valde contorta; antherae inclusae, per paria cohaerentes, 1.5 mm. longae et 2 mm. latae; ovarium albo-sericeum; stylus crassus, glaber; stigma stomatomorphum; disci glandula postica solum evoluta, glabra, tridenticulata.—COCLÉ: vicinity of La Mesa, north of El Valle de Anton, alt. 1000 m., May 12, 1941, *Paul H. Allen 2394* (U. S. Nat. Herb., nos. 1,793,972–3, TYPE); same locality, June 23, 1940, *Allen 2177* and May 14, 1939, *Allen 1787*.

Related to *Columnea purpurata* Hanst., which has larger leaves, not red beneath at apex, conspicuous bracts, and a larger calyx and corolla.

COLUMNEA **perpulchra** Morton, sp. nov. Planta epiphytica; caules non ramosi, crassi, basi ca. 7 mm. diam., apicem versus ca. 2.5 mm. diam., densissime brunneo-hirsuti, pilis saepe 6 mm. longis; folia per paria valde inaequalia, subsessilia, petiolo vix 2 mm. longo; lamina foliorum majorum oblongo-oblanceolata, usque ad 16 cm. longa et 4.7 cm. lata, apice breviter et abrupte acuminata, basi valde obliqua sed non auriculata vel amplexicaulis, serrulata, herbacea, supra viridis, pilosa, subtus apice rubra, vel interdum ubique rubra vel rubro-maculata, hirsuta, venis lateralibus ca. 11-jugis, subtus prominulis; folia minora stipuliformia, sessilia, ovata, usque ad 2 cm. longa et 1 cm. lata, longe et acriter acuminata, basi valde obliqua, basi inferiore auriculata, subamplexicaulia, utrinque hirsuta, subtus apice rubra; inflorescentia biflora, axillaris, basi bibracteata, bracteis lanceolato-subulatis, ca. 7 mm. longis, integris, acuminatis, hirsutis, viridibus, pedicellis gracilibus, ca. 2 cm. longis, hirsutis; calyx pallidus, erectus, lobis subaequalibus, ca. 2 cm. longis, 3 mm. latis (dentibus exclusis), acuminatis, laciniatis (laciniis subulatis, usque ad 3 mm. longis, ca. 6 utroque latere), externe pilosis, intus glabris; corolla lutea (lobis basi coccineis), ca. 4 cm. longa, basi subcalcarata (3.5 mm.), tubo externe glaberrimo, intus glabro, supra basim contracto et 3.5 mm. diam., abrupte deflexo et ventricoso et ca. 8 mm. lato, faucem versus paullo contracto, fauce ca. 7 mm. lato, limbo subregulari, lobis reflexis, externe parce strigosis, lobis 2 superioribus ca. 2 mm. connatis, alteris liberis, suborbiculatis, rotundatis, omnibus ca. 5 mm. longis, intus glabris, eglandulosis; filamenta basi in tubum 8 mm. longum postice fissum connata, glabra, plus minusve contorta; antherae inclusae, connatae, quadratae, ca.

2 mm. longae et latae; ovarium fere glabrum; stylus glaber; stigma bilobum; disci glandula postica solum evoluta, glabra, crassa, emarginata.—COCLÉ: hills north of El Valle de Anton, vicinity of La Mesa, alt. 1000 m., Jan. 21, 1941, *Paul H. Allen 2305* (U. S. Nat. Herb., no. 1,806,117, TYPE); COLON: Dos Bocas, Río Fató Valley, alt. 40–80 m., Aug. 16, 1911, *H. Pittier 4209.* The related species *C. silvarum,* described below, may be distinguished as follows:

Corolla tube entirely glabrous; leaves red beneath at apex, or sometimes all over. *C. perpulchra*

Corolla tube pilose externally, pilosulous at base within; leaves green, not at all red-spotted . . . . *C. silvarum*

COLUMNEA **rubra** Morton, sp. nov. Planta epiphytica; caulis stramineus, vix ramosus, strigosus, mox glaber; folia per paria inaequalia, majora brevissime petiolata, petiolo ca. 2 mm. longo, crasso, ca. 4 mm. diam.; lamina foliorum majorum anguste oblonga vel oblanceolata, usque ad 14 cm. longa et 4.7 cm. lata, acuta, basi subaequalis, rotundata, crassa, supra pallide viridis, glabra, subtus ubique rubra, strigosa, integra, nervo mediali valde incrassato, venis lateralibus ca. 8-jugis, supra obscuris, immersis, subtus prominulis; folia minora decidua; inflorescentia axillaris, biflora, bibracteata, bracteis lineari-lanceolatis, ca. 5 mm. longis, integris, externe rubro-strigosis, pedunculis ca. 1 cm. longis, dense rubro-strigosis; calyx ruber, ca. 1.9 cm. longus, lobis erectis, aequalibus, lineari-lanceolatis, ca. 5 mm. latis, longissime et acriter acuminatis, remote glanduloso-serratis (dentibus ca. 4 utroque latere), utrinque dense rubro-strigosis; corolla lutea, 7 cm. longa, in calyce erecta, basi subcalcarata (ca. 2 mm.), tubo supra basim 3 cm. lato, sursum gradatim ampliato, non ventricoso, fauce 11 mm. lato, externe piloso, pilis paucicellularibus, glanduloso-capitatis, galea 2.7 cm. longa, 1.4 cm. lata, integra, apice apiculata, lobis lateralibus ca. 1 cm. longis, cum galea longe connatis, lobo inferiore reflexo, lineari, 1.7 cm. longo, 4 mm. lato, lobis omnibus utrinque glanduloso-pilosulis; filamenta basi in tubum 5 mm. longum connata, glabra; antherae connatae, oblongae, ca. 2.2 mm. longae, 1.6 mm. latae; ovarium cylindricum, sericeum; stylus omnino glanduloso-pilosulus; stigma bilobum, glanduloso-pilosulum; disci glandula postica solum evoluta, glabra, crassa, integra.—COCLÉ: trail to Las Minas, north of El Valle de Anton, alt. 1000 m., May 10, 1941, *Paul H. Allen 2469* (U. S. Nat. Herb., no. 1,808,603, TYPE).

The above measurements for the corolla are taken from flowers preserved in liquid. In drying, the corollas contract a great deal.

The following measurements of dried corollas are given for comparison with herbarium specimens: Length 6–6.5 cm., tube above base 2 mm. broad, throat 7 mm. broad, galea 2.5 cm. long, ca. 7 mm. broad, lateral lobes ca. 7 mm. long, lower lobe ca. 1.4 cm. long.

The section Cryptocolumnea is a peculiar small one in which the corolla has the bilabiate shape of Eucolumnea, but the leaves are similar to those of Collandra. The only previously known North American species is *C. praetexta* Hanst. (Linnaea **34**: 394. 1865–66), originally collected at an undesignated locality in Costa Rica by Warscewicz, which has never been found again. *Columnea citrina,* described above, is certainly a member of the section, and the present species, *C. rubra,* will probably be found to belong there also, the corolla being that of Eucolumnea, but the leaves, by their shape and red coloration, suggesting those of Collandra. However, the characteristic stipuliform leaves are lacking on the specimen at hand. Another very distinctive species, *C. hirsutissima,* is described above. These species may be separated as follows:

Stigma stomatomorphic; calyx lobes entire or nearly so; bracts large (2 cm. long or more); leaves very oblique at base, with the lower side auriculate and amplexicaul, green beneath with a purple spot toward apex.

Bracts orbicular, crenulate; leaves villous above; stipuliform leaves 2.5–5 cm. long . . . . *C. praetexta*

Bracts lanceolate, entire; leaves glabrous above; stipuliform leaves about 2 cm. long. Style and stigma glabrous; calyx lobes glabrous within except on median line; corolla lobes glabrous within . . . . *C. citrina*

Stigma bilobed, glandular-pilosulous; calyx lobes serrate or denticulate, strongly pubescent on both sides; bracts small (not over 5 mm. long) or absent; leaves equal at base, not auriculate or amplexicaul. Style glandular-pilosulous throughout; corolla lobes hairy within.

Stems strigose; leaves glabrous above, strigose beneath, red over whole lower surface; filaments glabrous throughout; corolla yellow . . . . *C. rubra*

Stems densely long-hirsute; leaves hirsute on both sides, not red or red-spotted beneath; filaments glandular toward base; corolla red . . . . *C. hirsutissima*

Columnea **silvarum** Morton, sp. nov. Herba vel frutex, 0.6–3.6 m. altus; caules crassi, articulati, dense rubro-hispidi; folia per paria inaequalia, subsessilia, petiolo crasso, ca. 2 mm. longo; lamina foliorum majorum oblonga, usque ad 16 cm. longa et 5.5 cm. lata, breviter et abrupte acuminata, basi valde inaequalis et obliqua, non auriculata, non amplexicaulis, herbacea, glanduloso-denticulata, non rubro-maculata, utrinque viridis, pilosula, subtus in venis hirsuta, venis lateralibus ca. 10-jugis, prominulis; folia minora stipuliformia, lanceolata, ca. 1 cm. longa, 4 mm. lata, acuminata, basi obliqua, viridia; inflorescentia axillaris, 2- vel 3-flora, bracteis basalibus lineari-subulatis, ca. 8 mm. longis, 1 mm. latis, integris,

pedicellis 1.5–2.5 cm. longis, gracilibus, dense rubro-hirsutis; calycis lobi lineari-subulati, subaequales, 2–2.5 cm. longi, ca. 3 mm. basi lati, longissime acuminati, remote laciniati (dentibus subulatis, ca. 2 mm. longis, ca. 3 utroque latere), utrinque rubro-hirsuti; corolla lutea (lobis basi purpureis), in calyce erecta, 4–4.5 cm. longa, basi subcalcarata (3 mm.), tubo supra basim contracto et 4 mm. diam., tubuloso, sursum ampliato et paullo ventricoso, 1 cm. diam., fauce contracto et 7 mm. lato, externe parce piloso, intus basi pilosulo, limbo subregulari, non bilabiato, ca. 1 cm. lato, lobis patentibus, suborbiculatis, ca. 3 mm. longis, rotundatis, 2 superioribus altius connatis, intus glabris; filamenta basi in tubum 5 mm. longum postice fissum connata, glabra; antherae exsertae, cohaerentes, quadratae, ca. 2 mm. longae et latae; ovarium sericeum; stylus glaber; stigma breviter bilobum, parce glanduloso-pilosulum; disci glandula postica solum evoluta, crassa, glabra, bidenticulata.—DARIEN: in rain forest on the crest of the Cana-Cuasi Trail, Chepigana District, alt. 1500 m., Mar. 15, 1940, *M. E. and R. A. Terry 1566* (Herb. Field Mus., no. 1,035,998, TYPE). A second specimen in the Field Museum was collected near the same locality at 600 meters elevation, Mar. 11, 1940, *Terry & Terry 1499*.

This species and *C. perpulchra* differ strongly from other Panama species of the section Collandra in their elongate corollas, about twice as long as the calyces. In the other species the corolla is included in the calyx or is only very slightly exserted.

DRYMONIA ALLOPLECTOIDES Hanst. var. **vallicola** Morton, var. nov. A var. *typica* foliis minoribus, calycis lobis angustioribus, minus hirsutis, corolla minus obliqua, minus hirsuta, limbo minus obliquo differt.—COCLÉ: north rim of El Valle de Anton, near Cerro Turega, alt. 650–700 m., June 30, 1940, *R. E. Woodson & R. W. Schery 203* (U. S. Nat. Herb., no. 1,808,024, TYPE); same locality and date, *Woodson & Schery 162*.

The typical form of this species is confined to Costa Rica.

DRYMONIA **brevipes** Morton, sp. nov. Frutex epiphyticus, scandens, 3–5 m. longus, ramosus; rami teretes, glaberrimi, apicem versus ca. 4 mm. diam.; folia per paria paullo inaequalia, petiolata, petiolo foliorum majorum 1.5–2 cm. longo, glabro; lamina foliorum majorum anguste oblonga, 20–24 cm. longa, 4.7–6 cm. lata, acuminata, basi cuneata, aequalis, coriacea, integra, utrinque glaberrima, viridis, non rubro-maculata, venis lateralibus supra obscuris, sub-

tus elevatis; folia minora similia, sed ca. 9.5 cm. longa et 3 cm. lata; flores solitarii, axillares, brevipedunculati, pedunculo ca. 13 mm. longo, glabro, apice incrassato; calyx verisimiliter coloratus, valde obliquus, lobis 3, valde inaequalibus, lateralibus late ovatis, ca. 2.4 cm. longis, 2.2 cm. latis, apice bilobatis (ca. 4 mm.), lobo postico fere libero, multo minore, ovato-lanceolato, ca. 18 mm. longo, 12 mm. lato, obtuso, omnibus glaberrimis; corolla rosea, ca. 7 cm. longa, in calyce obliqua, basi obtuse calcarata (6 mm.), tubo supra basim 11 mm. lato, gradatim ampliato, non ventricoso, fauce ca. 13 mm. lato, utrinque glaberrimo, limbo subregulari, ca. 3.5 cm. lato, paullo obliquo, lobis patentibus, subaequalibus, suborbiculatis, ca. 13 mm. longis, rotundatis, subintegris, non fimbriatis; filamenta basi in tubum 9 mm. longum crassum postice fissum connata, glabra, contorta; antherae connatae, inclusae, oblongae, ca. 6.5 mm. longae, 2 mm. latae; ovarium parce strigillosum; stylus glaber; stigma stomatomorphum; disci glandula postica solum evoluta, glabra, crassa, acuta.—COCLÉ: hills in vicinity of La Mesa, north of El Valle de Anton, alt. 1000 m., Jan. 21, 1941, *Paul H. Allen 2330* (U. S. Nat. Herb., no. 1,806,119, TYPE).

Evidently a rather close relative of *Drymonia conchocalyx* Hanst. of Costa Rica, but with a quite different calyx. In *D. conchocalyx* the calyx is obviously 5-lobed, the 2 anterior lobes being connate high up. In *D. brevipes* the calyx is apparently 3-lobed, the 2 anterior lobes being only slightly connate, but each anterior lobe is almost wholly connate with a lateral lobe. In both species the posterior lobe is nearly free and much smaller than the others. *Drymonia brevipes* may be distinguished also by the very short, thick peduncles.

DRYMONIA LANCEOLATA (Hanst.) Morton, Field Mus. Publ. Bot. **18**: 1173. 1938.—In the 'Flora of Costa Rica,' I reported this species from Panama, but I do not now know on what basis. A definite record is: CHIRIQUÍ: Quebrada Velo, alt. 1800 m., July 8, 1940, *Woodson & Schery 268.*

DRYMONIA PARVIFLORA Hanst. Linnaea **34**: 352. 1865-66.—CHIRIQUÍ: vicinity of Bajo Mona and Quebrada Chiquero, alt. 1500 m., July 12, 1940, *Woodson & Schery 566.*

This distinctive species, which has the general appearance of the genus *Tussacia,* was originally collected at Candelaria, Costa Rica, by Hoffmann, and has since been known only from the type. The

specimen recently collected agrees perfectly with Hanstein's description.

DRYMONIA **parvifolia** Morton, sp. nov. Frutex parvus, epiphyticus; caules ca. 30 cm. longi, sulcati, glabri, apice ca. 4 mm. diam.; folia per paria aequalia, petiolata, petiolo 7–12 mm. longo, glabro, gracili; lamina foliorum lanceolata, 4–5.5 cm. longa, 1.3–2 cm. lata, obtuse acuminata, basi aequalis, cuneata, integra, papyracea, utrinque glaberrima, venis lateralibus 4- vel 5-jugis, subtus vix elevatis; inflorescentia axillaris, uniflora, bracteis nullis, pedunculo ca. 9 mm. longo, glabro; calyx irregularis, lobis liberis, 2 anticis anguste oblongis, 11 mm. longis et 3 mm. latis, obtusis, 2 lateralibus ovato-lanceolatis, 13 mm. longis et 5 mm. latis, acutis, postico ovato-lanceolato, 8 mm. longo et 3 mm. lato, acuto, omnibus integris, glaberrimis; corolla alba, ca. 2.5 cm. longa, in calyce horizontalis, basi postice calcarata (1.5 mm.), tubo basi ca. 3 mm. lato, sursum ampliato et in fauce non contracto, ca. 1 cm. diam., externe glabro, limbo terminali, subbilabiato, lobis magnis, externe pilosis, lacerato-dentatis; filamenta glabra; antherae cohaerentes, inclusae, oblongae, sagittatae, ca. 3 mm. longae; ovarium apice sericeum; stylus glaber; disci glandula postica solum evoluta, bidenticulata, glabra, crassa.—CHIRIQUÍ: trail from San Felix to Cerro Flor, alt. 100–850 m., Aug. 13–14, 1939, *Paul H. Allen 1949* (Herb. Missouri Bot. Gard., TYPE).

This species is another of those intermediate between *Drymonia* and *Alloplectus* sect. Erythranthus. It is not closely related to any other species, being distinguished by its entirely glabrous stems, leaves and calyces, very small and strongly unequal calyx lobes, and white corollas.

DRYMONIA **rosea** Morton, sp. nov. Planta epiphytica, erecta; caules ca. 30 cm. longi, subtetragoni, crassi, ca. 1 cm. diam., vix strigillosi; folia per paria subaequalia, breviter petiolata, petiolo crasso, vix 1 cm. longo, dense rubro-sericeo; lamina foliorum oblique ovata vel oblonga, subfalcata, usque ad 22 cm. longa et 8.5 cm. lata, acuta, basi obliqua, rotundata, subchartacea, apicem versus serrulata, supra viridis, scabro-strigillosa, subtus ubique rosea, praecipue in venis strigillosa, venis lateralibus 8–10-jugis, venulis ultimis subtus valde prominulis, reticulatis; inflorescentia axillaris, uniflora, bracteis minutis, subulatis, pedicello ca. 7 mm. longo; calyx viridis, lobis inaequalibus, acutis, anterioribus et lateralibus oblongis, 2.5–2.8 cm. longis, 1 cm. latis, postico ovato, 2.2 cm. longo et

12 mm. lato, omnibus acriter dentatis (dentibus subulatis, ca. 1 mm. longis, ca. 8 utroque latere), utrinque strigillosis, pilis minutis, rubris, glanduliferis; corolla lutea, in calyce valde obliqua, basi postice calcarata (2 mm.), tubo ca. 3.2 cm. longo, supra basim ca. 5 mm. diam., sursum ampliato, non ventricoso, in fauce non contracto, ca. 13 mm. lato, externe rubro-pilosulo, intus basi dense glanduloso-pilosulo, limbo obliquo, paullo bilabiato, lobo antico majore, ca. 9 mm. longo et 10 mm. lato, lobis lateralibus ca. 9 mm. longis et 7 mm. latis, lobis posticis ca. 5 mm. longis et 10 mm. latis, omnibus breviter fimbriato-dentatis (dentibus ca. 0.5 mm. longis), intus glabris; filamenta basi in tubum 7 mm. longum postice fissum connata, glabra, vix contorta; antherae liberae, inclusae, oblanceolatae, ca. 5 mm. longae, basi ca. 1 mm. latae, apice ca. 2 mm. latae, basi sagittatae, basi solum dehiscentes; ovarium sericeum; stylus dense pilosulus, brevis, crassus; stigma stomatomorphum; disci glandula postica solum evoluta, magna, crassa, glabra, paullo emarginata.—COCLÉ: vicinity of La Mesa, hills north of El Valle de Anton, alt. 1000 m., May 11, 1941, *Paul H. Allen 2489* (U. S. Nat. Herb., nos. 1,808,619–20, TYPE).

Perhaps related to *D. marmorata* Hook. and *D. turrialbae* Hanst., which also have leaves deep rose color beneath, but in these species the calyx lobes are entire or inconspicuously and irregularly crenulate; in *D. rosea* the calyx lobes are sharply and deeply subulate-toothed. In *D. rosea* the ultimate veinlets are elevated and very prominent beneath, giving a reticulation suggesting that of some genus of Rubiaceae such as *Sommera.* I have never seen any similar venation in the Gesneriaceae.

DRYMONIA TURRIALBAE Hanst. Linnaea **34**: 359. 1865–66.—In the 'Flora of Costa Rica' I reported this from Panama. The record on which this was based is *Pittier 5671* from Cerro de Garagará, Sambú Basin, Darien, alt. 500–974 m., Feb. 7, 1912. I have also examined another specimen in the Field Museum, *Terry & Terry 1421,* collected on the Cana-Cuasi Trail, Chepigana District, Darien, alt. 1200 m., Mar. 9, 1940. Neither of these collections has flowers in good condition for study, so it is possible that this Darien plant is different from the Costa Rican species.

GLOXINIA PALLIDIFLORA Hook.—CANAL ZONE: on large boulders in bed of waterfall, Government Forest Preserve, Madden Road, alt. 50 m., Nov. 29, 1940, *Paul H. Allen 2280.* Not previously collected wild in Panama.

MONOPYLE **panamensis** Morton, sp. nov. Herba terrestris; caules non ramosi, usque ad 70 cm. longi, puberuli; folia per paria inaequalia, longe petiolata, petiolo foliorum majorum usque ad 3.8 cm. longo, pilosulo; lamina foliorum majorum elliptica vel anguste elliptica, usque ad 20 cm. longa et 8.2 cm. lata, acuminata, basi valde obliqua, rotundata, tenuiter herbacea, grosse dentata, supra hirsutula, subtus puberula, venis lateralibus ca. 11-jugis, subtus prominulis; folia minora brevius petiolata, similia sed multo minora, ca. 4 cm. longa; inflorescentia terminalis, paniculata, 6–18 cm. longa, pedunculo communi 3.5–9 cm. longo, pilosulo, eglanduloso, apice bibracteato (bracteis subfoliaceis, viridibus, petiolatis), inflorescentiae ramis primariis brevissimis, usque ad 7 mm. longis, apice bibracteolatis (bracteolis subulatis, flavo-pilosulis), pedicellis 2–4, terminalibus, subumbellatis, inaequalibus, 2–22 mm. longis; calycis tubus cylindricus, ad anthesin ca. 5 mm. longus et 2 mm. latus, basi vix curvatus, ubique dense glanduloso-pilosulus; calycis lobi virides, oblongi, ca. 5 mm. longi et 1.5 mm. lati, obtusi, integri, crassi, externe pilosuli, intus apicem versus pilosuli, non recurvati; corolla basi alba, sursum caerulea, 1.2–1.6 cm. longa, late campanulata, in calyce obliqua, basi ecalcarata, non gibbosa, tubo basi ca. 4 mm. diam., sursum 11–13 mm. diam., externe pilosulo, intus glabro, limbo subregulari, ca. 1.7 cm. diam., lobis latis, rotundatis, intus glabris; filamenta libera, glabra; antherae cohaerentes, inclusae, ca. 1.5 mm. longae, loculis discretis, subdivergentibus; ovarium fere omnino inferum, pars libera conica, pilosula; stylus glaber; stigma stomatomorphum, glabrum; discus nullus; fructus capsularis, ca. 1.5 cm. longus, 3 mm. latus.—PANAMÁ: Cerro Campana, alt. 1000 m., Apr. 21, 1941, *Paul H. Allen 2413* (U. S. Nat. Herb., no. 1,793,920, TYPE); same locality, July 1, 1939, *Allen 1871.*

Related to *Monopyle puberula* Morton, of Costa Rica and Guatemala, but differing as follows:

Leaves long-petiolate (1.5–3.8 cm.); inflorescence (rhachis, pedicels and calyx tube) densely glandular-pilosulous; calyx and lobes hairy within; corolla 1.2–1.6 cm. long; stigma glabrous .... *M. panamensis*
Leaves short-petiolate (about 5 mm.); inflorescence eglandular-pilosulous; calyx and lobes glabrous within; corolla 2–2.8 cm. long; stigma pilose .... *M. puberula*

Monopyle Maxonii is related also, but differs as follows:

Inflorescence branches and pedicels glabrate; hairs of calyx tube with elongate, uncinate gland; calyx lobes red-purple, recurved at tip, glabrous within; lower leaf surface glabrous; corolla usually 2–3 cm. long; stigma pilose...... *M. Maxonii*
Inflorescence branches densely pilosulous; hairs of calyx tube with small, capitate gland; calyx lobes green, not recurved, hairy within; lower leaf surface strigose-puberulous; corolla 1.2–1.6 cm. long; stigma glabrous .... *M. panamensis*

Annals
of the
Missouri Botanical Garden

Vol. 29 APRIL, 1942 No. 2

CONTRIBUTIONS TO OUR KNOWLEDGE OF AMERICAN CARBONIFEROUS FLORAS

III. Stipitopteris

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The fossil described in this paper, a fern petiole fragment referable to the form genus *Stipitopteris,* was discovered in a coal-ball collected at the Pyramid Mine of the Binkley Coal Company, located three miles south of Pinckneyville in Perry County, Illinois. The coal in this mine is described as belonging to the lower McLeansboro series and is known as coal number 6. A more detailed discussion of the occurrence of coal-balls at this locality has been given in the first of this group of contributions (Andrews, '42).

Materials and Procedure.—The single specimen of this fern consists of a fragment of a petiole approximately 4 cm. long. The coal-ball containing it, numbered WBC170 in the collections of the Henry Shaw School of Botany of Washington University, was cut into six sections, each being approximately 13 mm. in thickness. The fern petiole was well preserved in the two center sections, but rather badly crushed and distorted in the two adjoining ones. Of the center sections, one was used to prepare a series of transverse peels while the other was used for longitudinal sections. It was possible in this way to observe the nature of the tracheid pitting as well as the distinctive transitional anatomy of the trace as a whole.

The nitrocellulose peel method was used in obtaining preparations. This method produced much more satisfactory preparations for study and photographic purposes than ground sections, chiefly

because the dark contents in the parenchyma cells of the latter made it very difficult to grind sections sufficiently thin.

Description.—The petiole is more or less oval in outline and measures approximately 10 by 13 mm. in diameter. The most distinctive feature is the transitional organization of the xylem of the leaf trace. At one end of the specimen (pl. 9, fig. 1) the trace is in the form of an elongated "horseshoe" with the free ends involuted, while at the opposite end (fig. 4) it forms a continuous band enclosing an isolated W-shaped segment. A selection from the peel preparations shows these extremities as well as two intermediate stages (figs. 3, 4) in the isolation of the W-shaped strand. Text-figures 1 and 2 show the organization of the xylem tissue of the leaf trace as reconstructed from the series of peel preparations. The actual distance through which the illustrated transition takes place is approximately 10 mm. The longitudinal dimension has been exaggerated somewhat in the text-figures in order to show the transition clearly.

The xylem of the trace, which is shown as the rather prominent white band in figs. 1-4, consists of primary metaxylem 2–4 cells wide with scattered groups of protoxylem located on the inner side. The metaxylem cells are uniformly scalariform (pl. 10, fig. 7) and vary from 15 to 91μ in transverse section, the average being about 47μ.

The protoxylem groups are endarch and numerous, being arranged around the entire inner periphery of the metaxylem, although they are more numerous in the involuted portion of the trace (fig. 1). It is difficult to ascertain the exact number of protoxylem groups, partly because of faulty preservation in spots and partly because the size distinction is not always great between metaxylem and supposed protoxylem. The number is approximately 25–30 and the average size of a clearly defined protoxylem cell is 21μ. In the isolated W-shaped strand they are found on the upper side, as the petiole is illustrated in fig. 3. This corresponds to the inner side of the surrounding cylinder.

Scott ('09), in describing the protoxylem of *Caulopteris,* does not mention the number of protoxylem groups present but only says that they occur, "as a number of small groups of cells on the inner edge of the xylem, which is thus endarch" [page 302]. This agrees with the specimen described here which has been shown to have centrally located protoxylem groups.

Phloem, pericycle and endodermis are not preserved. In all our

preparations the inner cortex is rather closely appressed to the xylem although there is some evidence that a tissue (or tissues) was formerly present between them. If such were the case it must have been a very narrow layer.

The cortex presents a number of distinctive features. Taken as a whole, it is composed of two sharply defined zones. The outer one reaches a thickness of a little more than 1 mm. and consists of cells which are large, thin-walled and rather badly crushed due to their apparently delicate nature in life. The inner zone averages about 1.5 mm. thick and consists of somewhat smaller cells partially filled with an opaque substance which may represent metamorphosed tannin or gum deposits. These two zones are separated by a narrow band of dark brown, closely compacted cells suggestive of meristematic activity. The pith or central parenchymatous mass consists of isodiametric cells with some dark contents but these are not so abundant as in the inner cortex.

Taxonomy.—There is little doubt that this petiole belongs to a stem of one of the Carboniferous tree ferns known from structually preserved remains as *Psaronius* and it evinces leaf scars of the *Caulopteris*[1] type. This is evident from a comparison of the Illinois specimen as shown in figs. 1–4 with *Caulopteris varians* Renault and Zeiller ('88) (pl. 10, fig. 5). The portion of the stem of *C. varians* in Renault and Zeiller's figure shows leaf scars at slightly different levels, and since the transition of the leaf trace takes place rapidly the comparison is possible. One of the bundle scars shown in their figure presents the elongated horseshoe type of trace similar to that in the Illinois specimen shown in pl. 9, fig. 1. Another bundle scar on the same portion of the stem shows the trace as a continuous band with the isolated W-shaped segment within the outer band (c.f. pl. 9, fig. 4).

Since the petiole described here was not found attached to the stem of *Caulopteris,* though there is little doubt that it was originally, it becomes necessary to describe it under the name *Stipitopteris.* That genus was introduced by Grand'Eury in 1877 for petioles of ferns whose structure in cross-sections corresponds to the marks on the leaf scars of *Caulopteris,* but which were not known in organic connection with the latter.

The leaf scars of certain species of *Stemmatopteris* Corda, de-

[1] The name *Caulopteris* was first used by Lindley and Hutton ('32) for supposed stems of the tree fern *Psaronius* which had been preserved as casts showing only surface features.

scribed by Lesquereux ('80) from the Carboniferous formation of Pennsylvania, show a similarity to a cross-section of the petiole described in this paper. *Stemmatopteris* and *Caulopteris* are undoubtedly closely related or even congeneric, and Lesquereux himself wrote that "the whole number of our species could have been described without inconvenience under the name of *Caulopteris.*" Hirmer ('27) considers the two congeneric.

There is also a striking similarity between the petiole described here and species of the genus *Anachoropteris* Corda. Darrah ('41), in his recent account of the Coenopterid ferns of the American coal-balls, points out that the taxonomic limits of *Anachoropteris* are in considerable doubt and that some of the forms included in the genus are now known to be portions of plants really belonging to other genera. He states, however, that the involute stele of most of the species seems to constitute a generic character. Corsin ('37), in his treatment of *Anachoropteris,* speaks of the protoxylem as occurring on the outside of the metaxylem rather than on the inside as in *Stipitopteris.* This apparent difference, in conjunction with the similarities between both of the aforementioned genera, brings up the question of the taxonomic value of the location of the protoxylem. Tansley and Lulham ('05) considered that in many cases it is of considerable significance, and they point out the universal exarchy of the steles of the Sphenophyllales and Lycopodiales and the endarchy of the Angiosperms. However, they conclude that the Filicales are rather different in that the exact position of the spiral protoxylem in relation to the metaxylem of the vascular strands of the stem is decidedly variable. They found exarchy, endarchy and mesarchy all within comparatively small groups, and concluded that the actual course of evolution seems to affect the position of the protoxylem much more freely and rapidly than in the other great groups of vascular plants. From this evidence it would seem that the use of the location of the protoxylem to separate genera in this group of ferns might be questioned. It is, however, evident that the stability of this character varies in different groups.

It is probable that an extensive taxonomic revision of the genera *Anachoropteris, Caulopteris, Stipitopteris* and *Psaronius* will be necessary in the future. This paper is intended as a further contribution to the apparent relationship between petioles described as *Anachoropteris* and *Stipitopteris* and fern stems described as *Psaronius* and *Caulopteris.*

STIPITOPTERIS

Grand'Eury ('77) described four species of *Stipitopteris* from the Carboniferous of France. His descriptions are very brief, and his only illustration is the cross-section of a petiole which is merely labeled *Stipitopteris.* It is interesting to note, however, that the isolated strand of xylem in his specimen is turned in the exact opposite direction from the Illinois specimen. Since the Illinois specimen is quite distinct from any described species of *Stipitopteris* it is described here as a new species.

Stipitopteris americana Lenz, sp. nov.—Petioles somewhat oval, 10 by 13 mm. in diameter; cortex consisting of two distinct zones, the outer approximately 1 mm. in thickness and formed of cells which are large, thin-walled and rather badly crushed, the inner about 1.5 mm. in thickness and consisting of somewhat smaller cells partially filled with an opaque substance; zones separated by a narrow band of dark closely compacted cells; leaf trace in the form of an elongated horseshoe with the ends involuted and fusing to form an isolated W within a continuous xylem cylinder; protoxylems endarch, of spirally thickened tracheids in small scattered groups; metaxylem 2–4 cells thick, consisting of scalariform-pitted tracheids, 15–91 μ in diameter.

Locality: Pyramid Mine of the Binkley Coal Company, Perry County, Illinois.

Type: Coal-ball WCB170 in the collections of the Henry Shaw School of Botany of Washington University.

Acknowledgment.—The author wishes to express his appreciation to Dr. H. N. Andrews who suggested the problem and under whose direction the work was carried out; to Dr. A. H. Blickle, for helpful suggestions relative to the natural affinities of the fossil described; and also to the Binkley Coal Co., for its continued kindness and cooperation in extending the privilege of collecting coal-balls from the mine.

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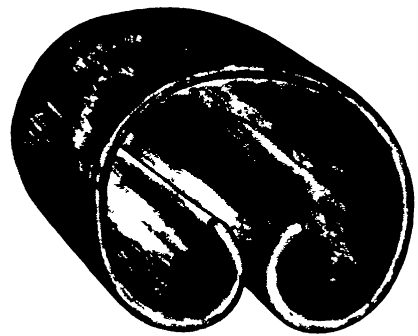


1

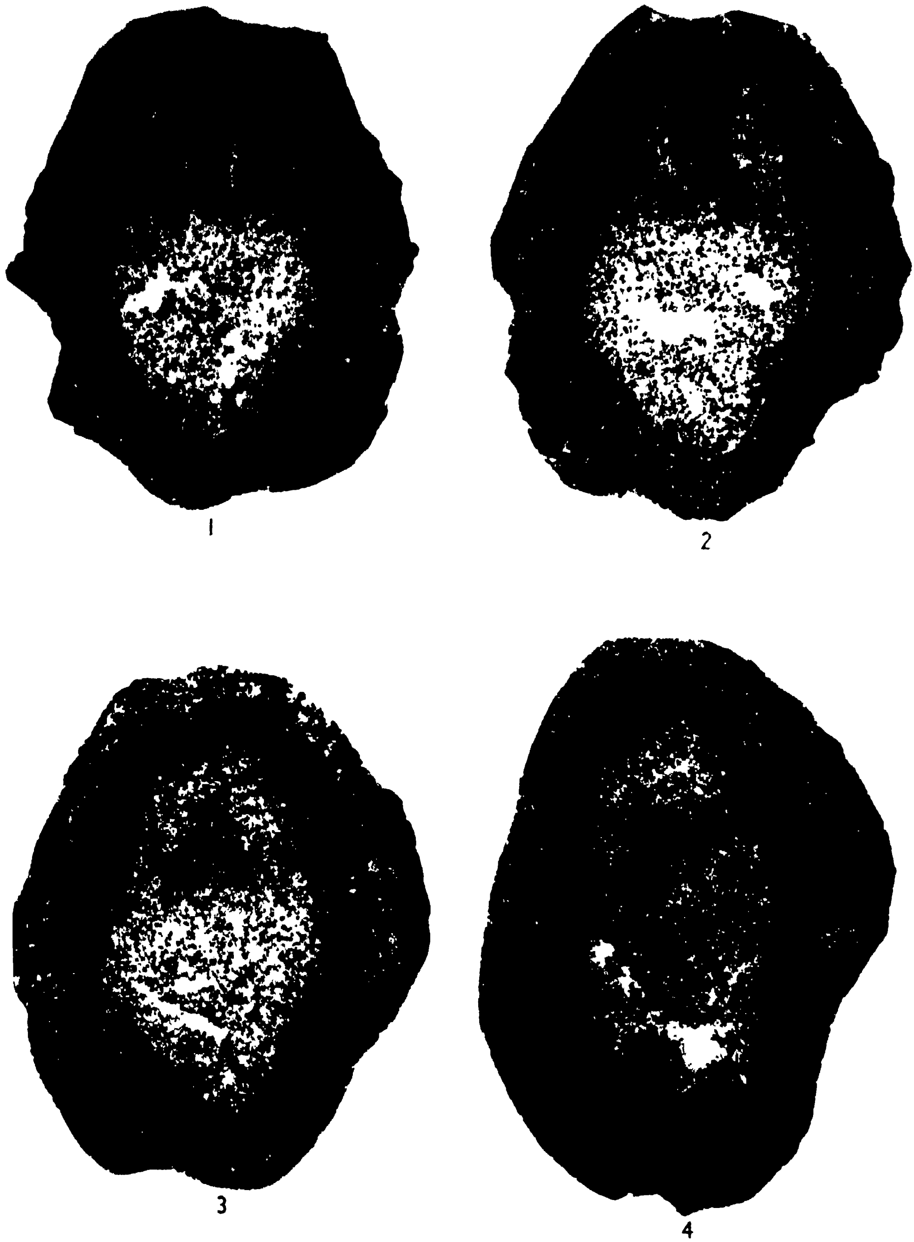
2

Text figs. 1, 2. *Stiptopteris americana.* Reconstruction from a series of peels showing the transition of the xylem tissue from the horseshoe shape, shown in fig. 1, to the cylinder of xylem enclosing the isolated W-shaped segment, shown in fig. 2.

Explanation of Plate

PLATE 9

Figs. 1–4. *Stipitopteris americana.* Part of a series of peel preparations showing the transitional anatomy of leaf trace; fig. 1, WCB170D.B9, fig. 2, WCB170D.T40a; fig. 3, WCB170D.T25; fig. 4, WCB170D.T8. All figures × 5.



LENZ—AMERICAN CARBONIFEROUS FLORAS. III

Explanation of Plate

PLATE 10

Fig. 5. *Caulopteris varians* Renault and Zeiller. From Renault and Zeiller ('88).

Fig. 6. *Stipitopteris americana* Lenz. Longitudinal section showing the spirally thickened tracheids of the protoxylem; WCB170C.S18, × 110.

Fig. 7. *Stipitopteris americana* Lenz. Longitudinal section showing the scalariform-pitted tracheids of the metaxylem; WCB170C.S21, × 110.

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LENZ—AMERICAN CARBONIFEROUS FLORAS. III

RACES OF ZEA MAYS: I. THEIR RECOGNITION AND CLASSIFICATION[1]

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It is now half a century since E. Lewis Sturtevant ('85, '86, '87, '94, '99) reviewed the variability of *Zea Mays* and catalogued it in six main groups, five of which were based upon the composition of the kernel. There are now available two new kinds of facts in addition to those which were at his disposal. In the first place, archeological research has made great advances and the museums of this country have numerous collections of prehistoric corn, the best of them in a remarkable state of preservation, their age approximately dated by dendrochronology (Guernsey and Kidder, '21). In the second place, the rise and development of corn genetics have provided us with a large body of technical information concerning the relationships of different kinds of corn. We know, for instance, that the change from flint corn to flour corn is controlled by a single gene difference, whereas the change from a flint to a dent is the result of many genes, so that in working out the relationships of corn the difference between flint and flour is trivial compared to the difference between flint and dent.

Mangelsdorf and Reeves have recently ('38, '39) advanced a new theory as to the relationships between corn and its closest relatives. For the examination of this hypothesis, or of any hypothesis dealing with the history of corn, it is important that the classification of the varieties of maize be re-examined in the light of our present knowledge of their history and relationships. For this purpose Sturtevant's classification has another disadvantage in addition to the fact that it does not incorporate the modern evidence. It is largely *artificial* rather than *natural*, as he himself was well aware ('94, p. 320).

[1] Much of the work reported in this paper was made possible by two grants from the Penrose Fund of the American Philosophical Society, to whom grateful acknowledgment is made.

It is not only in the classification of maize that one has to choose between these two methods, the natural and the artificial. Which to choose is one of the fundamental problems of all attempts at classification. Each method has its advantages and disadvantages. An artificial classification is an efficient catalogue and nothing more; it sets up a comprehensive series of pigeon-holes. A natural classification attempts in addition to put closely similar objects in adjacent pigeon-holes. An artificial classification may be simple, objective, rapid and complete, but it tells us little more than the pigeon-hole number of the catalogued object. A natural classification is often difficult, incomplete, and more or less subjective, but in addition to cataloguing an object it tells something about what *kind* of an object it is.

In most taxonomic work natural classifications are seldom attempted within the limits of a species or sub-species. Though a monographer may often realize that the individuals which he is lumping together as one species are grouped into more or less well-defined natural races, nevertheless he seldom has the time or the special training for attempting *intra*-specific classification. But though the problem may be difficult it cannot be ignored by those who work with man or domesticated plants and animals. While, for such problems, a wholly natural classification would be desirable, a more or less artificial one usually has to be adopted for practical reasons. In dealing with the people of a community, for instance, the telephone company lists them alphabetically. Like any good artificial classification, the telephone book is complete, objective, and requires no special training either to make or to use. It is convenient but it does not put similar people in adjacent positions. The O'Connors find themselves next to the Ochsners and the Cabots to the Cabrilliacs. When a sociologist studies the same community he might like to have a complete natural classification in which the O'Connors would go near the Kellys, and the Cabrilliacs with the Oldanis. In practice he must be satisfied with a few large natural groupings such as nationality, occupation, income, etc. Anything more elaborate than this is seldom put down on paper because it is too difficult.

Sturtevant's classification of corn was both artificial and natural, principally the former. It had six main subdivisions. One was pod corns. The other five considered only the composition of the kernel: the pop corns, the flint corns, the dent corns, the flour corns, and the sweet corns. To the extent that any two corns with the same kind

of kernel are by that very fact somewhat alike, it did put similar kinds of maize together. On the other hand, as Sturtevant himself pointed out, by ignoring other features of the maize plant, it often separated varieties which naturally belonged together. This system had exactly the advantages and the disadvantages of a classification of mankind based entirely on hair color. Such a classification would be rapid and complete and would, to a certain extent, group like peoples together, but it would separate a black-haired Norwegian from his fair-haired relatives and put him in the same class with Sicilians and gypsies.

The problem of races and their recognition is indeed almost the same in *Zea Mays* as in mankind. In both cases it is not easy to work out the racial composition of the whole and it is difficult to give a precise definition to the term "race." The latter problem has been discussed by Coon ('39) in the introduction to his book on the races of Europe:

> "Since man is the oldest domestic animal . . . any attempt to classify him by a rigid scheme is immensely difficult and the scheme must be elastic if it is to work at all. Hence the term 'race' must also be elastic. We may recognize if we like, certain major races of the Old World such as the Bushman-Hottentot, the Pygmy, the Australoid, the Negro, the Mongoloid, and the White. Within each of these major racial groups there are, or have been, smaller entities, which may deserve the designation of race in a lesser sense. These smaller entities consist, for the most part, of groups of people reasonably isolated, and developing into local physical enclaves. . . . At what border point such an entity becomes a major race it is not always possible to say."

For the classification of *Zea Mays* we shall define the word race as loosely as possible, and say that a race is a group of related individuals with enough characteristics in common to permit their recognition as a group. The last three words should be emphasized. As Hooton has said in his discussion ('26) of racial analysis, "races are great groups and any analysis of racial elements must be primarily an analysis of groups, not of separate individuals. One must conceive of race not as the combination of features which gives to each person his individual appearance, but rather as a vague physical background, usually more or less obscured or overlaid by individual variations in single subjects and realized best in a composite picture."

From the standpoint of genetics a race is a group of individuals with a significant number of genes in common, major races having a smaller number in common than do sub-races. The degree to

which a species can be divided into recognizable races and sub-races will depend upon the degree to which it has been divided into distinct intra-breeding groups with distinctive combinations of genes.

In the recognition of race in *Zea Mays* it is therefore essential that we rely upon characters with a broad genetic background (such as cob shape and kernel size) rather than those which are indicators of but a single locus (as starchy vs. sweet or flint vs. flour). A natural classification of the races of *Zea* based upon characters like cob shape, kernel size, and tassel type will be incomplete, and one must expect disagreement as to details, even among authorities. For some time to come it must be a goal to work towards rather than a project to be completed. As a basis for understanding the history and genetics of corn, it is worthy of such long-continued effort. Since it is an attempt at a classification based upon the entire germ-plasm, it will integrate the maximum number of genetic facts.

This does not mean that the races defined in this paper will supplant Sturtevant's classification as a cataloguing device. Any large enumeration of the varieties of corn must still be indexed by his system or by some such artificial system, though eventually some of the features of a natural system should be worth incorporating in a new comprehensive classification. For that reason no Latin names or precise diagnoses are given to the races of corn tentatively recognized in these papers. We have instead given short descriptive names to some of those groups of varieties in our collections with a recognizable core of common features.

A person who is acquainted with *Zea Mays* only in one section of the world will be amazed at a collection of varieties from another region. In the United States, for instance, maize is so variable that one who has not seen it elsewhere would think that it could not ever be much more variable. Yet a collection from a single Mexican state will show at least one and sometimes two or three new races. Each will have a variability of its own and will differ from the maize of the American corn belt. A discussion of the North American races of *Zea Mays* must therefore begin with a description of its total variability, with special reference to those features which distinguish the maize of one region from that of another.

A SURVEY OF INTER-RACIAL VARIABILITY IN MAIZE

For purposes of description (see Weatherwax, Chapters v–ix, xiv–xv) we may divide a plant of *Zea Mays* into root and shoot. The

shoot consists of a primary axis, which often gives rise to secondary axes at its base. The primary axis is composed of a variable number of nodes with a leaf at each, and is prolonged into a compound male inflorescence, commonly called the tassel. At one or more of the nodes, short secondary branches arise with short wide foliar organs (the husks) and terminated by a condensed compound female inflorescence (the ear). Smaller ears arise in the axils of these foliar organs but they seldom develop to a functional stage.

Root.—

Though variation in the root is not as conspicuous as that in the shoot, it certainly exists (see Collins, 1918). Some Mexican and southwestern races of corn have much longer mesocotyls and many of the varieties of the Mexican plateau have poorly developed root systems as reported by Kuleshov ('30). We have not as yet been able to work out any standardized measurement of these characters which can be used as a criterion of race.

Branching of the Primary Axis.—

The degree of branching of the primary axis and the relative development of the primary and secondary axes vary greatly in different races of corn. They are so unlike in the same variety of corn when it is planted in widely separated localities or at different times of year that we have not found it practicable to use this character as a criterion. The proportionate development of primary and secondary axes (stalk and tiller) is a more stable character and, with a little more study, might be found useful.

Node Number and Internode Length.—

Races of corn differ significantly in node number, but it is too affected by the environment to be useful as a racial criterion. The fundamental pattern of internode length is perhaps more stable and with a little further study might be found useful. Figure 1 shows the pattern of internode lengths in four different races of corn. It will be seen that there are considerable differences in the degree to which the internodes lengthen immediately above the uppermost ear.

Leaves (Blade and Sheath).—

The leaves of the various races differ greatly not only in their absolute size but in their proportions, as has already been commented upon by Kuleshov (loc. cit.). There is so much variabil-

ity upon each plant that we have not been able to determine an efficient method of scoring leaf shape. The leaf sheaths differ in their hairiness from race to race, and this we have been able to score in three qualitative grades, slight or none, evident, and heavy.

Male Inflorescence.—

The tassel of *Zea Mays* presents us with more easily measured characters than all the rest of the plant combined. While the homologues of its variation are present in the ear, the mature cob is so grown together and lignified that it is difficult to dissect and recognize the component parts.

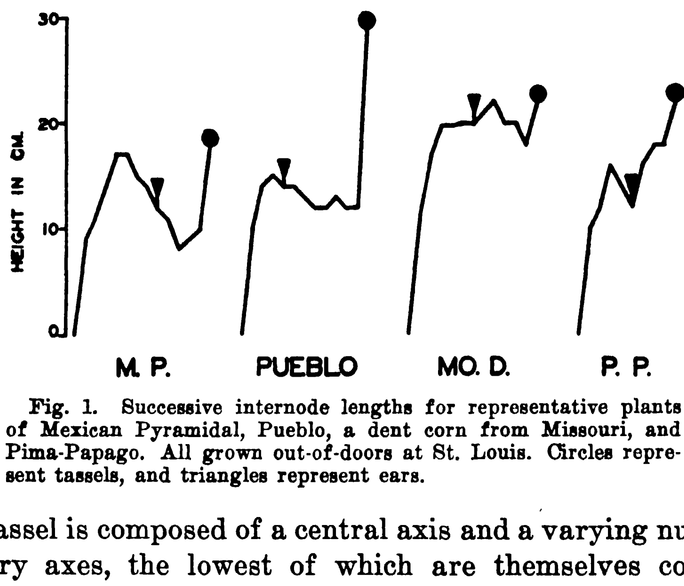


Fig. 1. Successive internode lengths for representative plants of Mexican Pyramidal, Pueblo, a dent corn from Missouri, and Pima-Papago. All grown out-of-doors at St. Louis. Circles represent tassels, and triangles represent ears.

The tassel is composed of a central axis and a varying number of secondary axes, the lowest of which are themselves compound (Weatherwax, pp. 100–102). The spikelets tend very strongly to be arranged in pairs, one sessile and one pedicellate. The spikelet pairs are arranged distichously upon the secondary axes and polystichously upon the central spike. Although all these features are subject to variation, the general plan remains remarkably constant in different races of corn. The number of tassel branches is a surprisingly stable character (Weatherwax, p. 102) and is one of the most useful criteria of race. To be sure, it is a character which is affected by the vigor of the plant and for that reason we did not consider using it until experience forced its general stability upon our attention. It was first brought to our notice in connection with Cutler's collections of maize from the Mexican Plateau for which we had (1) tassels collected in the Mexican corn fields, (2) tassels

grown in the greenhouse at St. Louis, (3) tassels from corn started in the greenhouse and ripened out of doors, (4) corn planted out of doors in St. Louis in May. While for each of these four lots the material was variable, the variation in each was from 0 to 4 branches. At the same time we also had in cultivation corn from Guatemala which bore a very large number of tassel branches though planted at the same time and in adjacent rows.

It was also found to be generally true that the range of variation in number of tassel branches was roughly the same for those cultures grown in triplicate at College Station, Cuba, and St. Louis (see pl. 11, tassels D and E).

In one characteristic Mexican race there are no branches or only a few, while in South American corns there may be 30 or more branches. The stiffness of the entire tassel and the angle at which its branches depart from the primary axis is useful in the field but we have not been able to score it effectively on herbarium specimens. The size of the outer glumes of the spikelet is also important. It varies from 8 or 9 mm. in some South American corns to 15 or 16 mm. in corn from the Mexican plateau. The length of the sterile zone at the base of the branches is also significant. This varies from 1 or 2 mm. in some Mexican corn to 10 or 20 mm. in certain South American varieties. Two technical characters are highly diagnostic of certain races, the condensation of internodes and the degree to which the pedicel on the upper spikelet is developed. In Peruvian corn successive internodes are equal in length and exhibit a characteristic, regular zigzag arrangement. In many North American varieties the internodes vary in length and are often so short that the spikelets appear as if borne four at a node. Two successive nodes may be so close together that they appear as one. In the corns of the Mexican plateau this condensation is sometimes quite regular, every second internode being condensed (fig. 2).

The spikelets, as has been said, occur in pairs, the upper spikelet of each pair being more or less pedicellate. The relative length of this pedicel varies greatly, however. In some South American corns it may be as long as the spikelet. In many Mexican corns it is subpedicellate and may even be quite as sessile as the lower spikelet. Plate 11 A shows an extreme example, a corn from Xochimilco in which all the spikelets are sessile and the alternate internodes condensed so that it has the appearance of bearing spikelets in whorls of four.

Female Inflorescence.—

Next to the tassel the most important criteria of race are to be found in the female inflorescence (the ear). The number of husks and their shape are highly diagnostic but we have not used it because ears with husks attached are difficult to store and to study. Ear and kernel were the basis of Sturtevant's classification and we have merely selected those of his criteria which seemed most diagnostic;

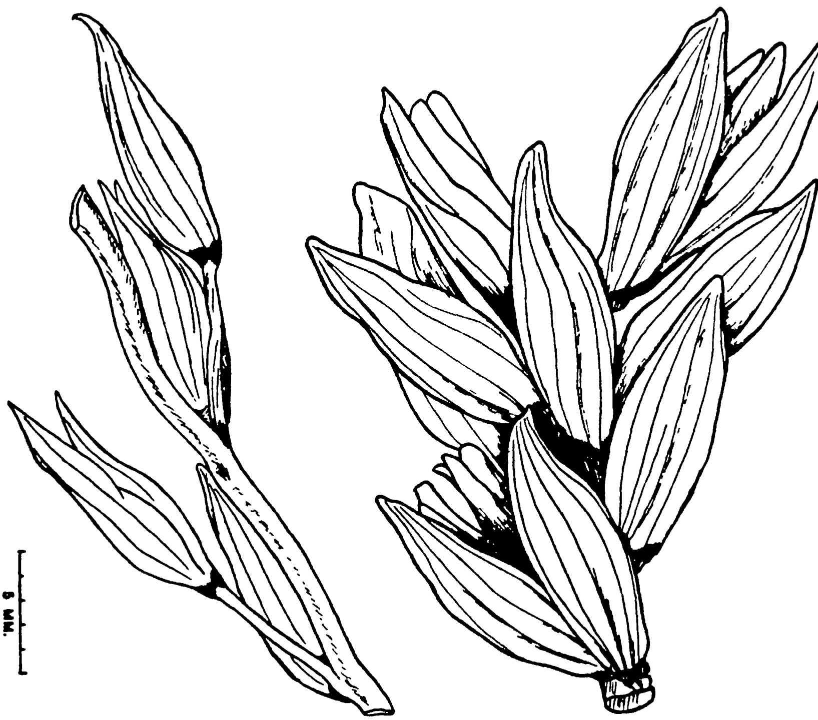


Fig. 2. Portions of tassel branches, greatly enlarged: left *Mangelsdorf 128852*, from Quinta, Peru; right, *Cutler 45*, from Xochimilco, Mexico.

row number, ear length, kernel width, thickness and length, and cob width. The composition of the kernel is an important racial criterion only to the extent that it is based upon a large number of genes. Starchy vs. sweet or flint vs. flour are simple gene differences and therefore of minor importance. Denting and capping, on the other hand, are the results of larger numbers of genes and are therefore more important though they are difficult to measure. Color differences, for the most part, are the results of a few gene differences and are somewhat superficial. However, it will be seen that when the races of maize have been separated on other grounds that each has its own characteristic color range.

In addition to these readily scored features, there are a number of general differences in ear shape, kernel pattern and kernel texture which are easily perceived by the trained eye but which are difficult to score objectively and commensurately (i.e., in a graded series). These include: (1) the general shape of the cob, cylindrical, long-tapering, short-tapering, (2) the shape of the butt, appressed, rounded or enlarged, (3) the extent to which the kernels are arranged in evident rows, (4) the sulci between the rows, (5) the regularity of the kernels (i.e., the amount of variation in size and shape from kernel to kernel), (6) the degree to which the kernels have been compressed by the husks.

The general problem of recognizing and measuring races has been discussed by Hooton ('26) in one of his classic contributions to the subject. Though he was considering mankind rather than *Zea Mays*, the problem is fundamentally the same and our techniques differ from his only in detail. Our material, however, had the advantage that we had two sets of complicated organs for analysis rather than one. His work was mainly limited to skulls. Ours had not only the ear but also the associated tassel. We followed his method in sorting out the ears by general perception, using the total impression given to the trained observer by its totality of characters. Having grouped his crania by this method, Hooton then measured them and computed averages for each recognized race, sub-race, etc. We had a somewhat better check on our conclusions since we first sorted the ears and then measured and averaged the associated tassels. In every case the exact *data* derived from the tassels confirmed our *judgments* with regard to the ears. Both of these conclusions received additional confirmation when the distributions of the races and sub-races were determined and were found to agree with recognized geographical and ethnic barriers. We had an added advantage in that much of our material was grown in triplicate at St. Louis, Mo., College Station, Texas, and Cienfuegos, Cuba, so that we had a rough idea of what differences were purely environmental. We are indebted to Dr. Paul C. Mangelsdorf and the Arnold Arboretum for the Cuban collections and to Dr. R. G. Reeves and the Texas A. and M. College for that grown at College Station.

The general method of work can be illustrated by our procedure with the collections from the southwestern United States. (These are to be discussed in greater detail in a forthcoming article by Anderson and Carter). For this area we had about fifty collections

made in the Southwest over a series of years by the junior author and by George F. Carter, to whom we are greatly indebted not only for a comprehensive collection but for much pertinent information. The tassels were collected and numbered by an assistant to reduce the personal equation to a minimum. The ears (some of them collected in the Southwest, others grown from seed collected there) were spread out on a large table and were carefully examined. It

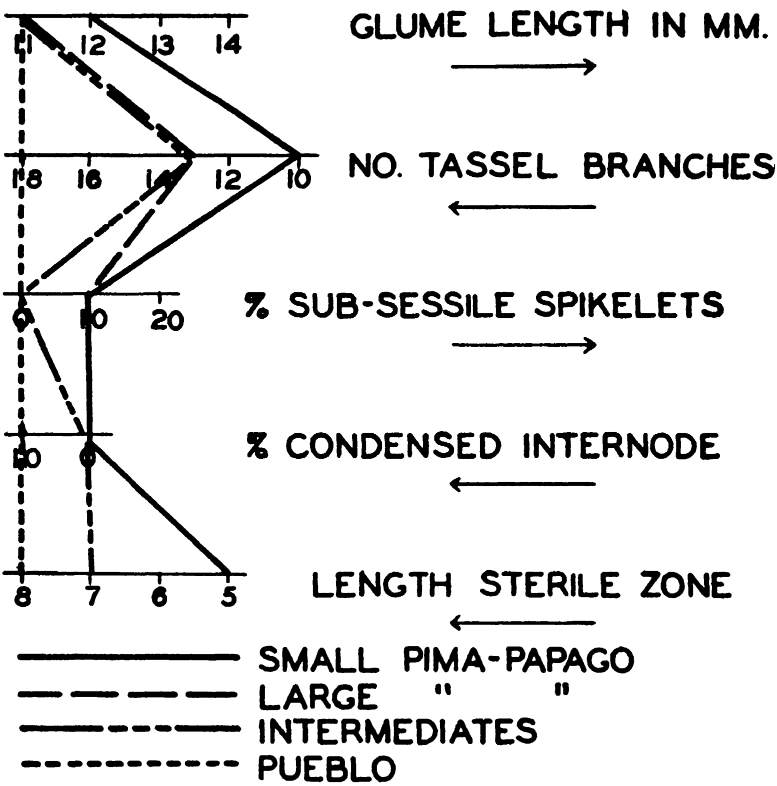


Figure 3

was almost immediately apparent that there were at least two centers of variation: (1) the large-cobbed, straight-rowed varieties grown by the Pueblo Indians, and (2) the small-cobbed mosaic-seeded type grown by the Pima and Papago Indians. We therefore sorted the material into three piles, "Pueblo," "Pima-Papago," and unknowns. By study it was possible to reduce the third pile little by little and we soon came to the conclusion that, aside from a few obvious recent admixtures such as pop corns and dents, there were only these two basic races of corn in the Southwest. The ma-

terial lent itself to classification in four groups: (1) Pueblo, (2) obviously intermediate, (3) Pima-Papago, but somewhat intermediate, and (4) Pima-Papago. We then studied the numbered tassels and measured five features previously chosen as racially diagnostic. Averages for each of the four groups were then computed and are shown diagrammatically for all 5 characters in fig. 3. It will be seen that five measured characters of the tassels agree with our total impression of the ear and kernel. The Pima-Papago and Pueblo are extreme for each of the five tassel characters, the intermediates occupy an intermediate position, and the averages of class 3 depart only slightly from those of the Pima-Papago.

The distribution of these two races among the southwestern Indians was then examined and found to agree with geographical and ethnic barriers. The Pueblo varieties are grown by the pueblo-dwelling Indians of the plateaus, the Pima-Papago by the Indians inhabiting the intensely hot deserts near the delta of the Colorado. The Pima-Papago varieties are not grown at all by the eastern Pueblos and are found only among those western Pueblos (most particularly the Hopi) which have for some centuries been isolated from the main group of Pueblo Indians and which are geographically much closer to the territory of the Pima and the Papago.

After the classification of the southwestern maize had been completed the Mexican and Guatemalan collections were studied in the same way. For these areas, in addition to the material collected by Cutler, we had extensive collections which came to us through the courtesy of Prof. Carl Sauer and Prof. Ralph Beals of the University of California, and a small but extremely useful collection of tassels and associated ears made in Mexico by our colleague, Mr. R. W. Schery. For these areas our collections are not so comprehensive and the variation of *Zea Mays* is much more complex. There are undoubtedly numerous sub-races which we have not yet recognized and some of those which we are now recognizing may ultimately prove to be intermediates. They are put forward tentatively as a basis for the discussion that may eventually give us a comprehensive yet natural classification of the races of *Zea Mays*.

The three Central American races (or sub-races) which we are describing below under the names of "Guatemalan Big Grains," "Mexican Pyramidal" and "Guatemalan Tropical Flints" are advanced merely as a basis for study. Their relations to each other and to the other races of Central and South America remain to be

determined. They do not constitute the only races in our collections and it is not even suggested that the three groups are of the same rank. It is quite possible that when the racial composition of corn has been thoroughly worked out one of these three might constitute a major race and the other two would be of subordinate rank. Though all three are variable each one has enough of a core of common features and a definite enough distribution in space and time to be thought of as an entity.

In the southwestern United States the corn situation is simpler and we have much more comprehensive collections. The two races, "Pima-Papago" and "Pueblo," which we are describing below, are certainly the two main entities in the maize grown by the Indians of that region. Aside from the obvious intermediates discussed above, the only other perceptible influences are admixtures derived from the American and Spanish communities and various Mexican types brought in by Apache raids.

Mexican Pyramidal (fig. 4; pl. 11 A, B, C).—

This is the common corn of the region about Mexico City and was probably therefore closely associated with the Aztecs. It is so distinctive in leaf and habit that it was named *Zea hirta* over a hundred years ago by Bonafous (1836) and was described in detail by Kuleshov ('30), who called it the "central Mexican type" and described its pubescent leaf sheaths, drooping leaves, poorly branched tassels, and weak root systems. He also called attention to the fact that this type might have kernels which were pop or flour or dent "as well as any other form of maize." In addition to the characters described by Kuleshov, the Mexican Pyramidals have long harsh glumes in the tassel and a high percentage of condensed internodes and subsessile upper spikelets (pl. 11 and fig. 4). The ears are equally distinctive. Though varying greatly in size they all have the same general shape. They are relatively short and taper sharply and regularly, hence the name "Pyramidal." Row pattern varies from regular to irregular with mixtures of both being common. They most generally show little husk compression; there are wide spaces between the rows and often between individual grains. The kernels are prevailingly long though they vary in shape, usually on the same ear, pointed to dented to rounded kernels often occurring together. The kernel is nearly always elongated, however, and the denting is usually a slight depression towards the tip of the grain. White is the commonest color, accom-

panied by heavy white capping, but dark reds and blue-blacks are also met with.

This race is of particular importance not only because of its probable association with Aztec civilization but because it apparently has entered into the make-up of our corn-belt dents. Any one who will examine large fields of non-inbred dent corn can find (in a greatly reduced degree) much of the same variation which characterizes the ears and tassels of the Mexican Pyramidals. Many of the inbreds derived from dent corns exhibit in an exaggerated form certain of the characters to be found in Mexican Pyramidals though in any one inbred they are usually combined with other quite different features. The Mexican pop corns apparently form a subrace of the Mexican Pyramidals since in our material their tassels are indistinguishable and their cob shapes (as distinct from cob size) and kernel shapes are practically the same. More material must be examined before this conclusion can be accepted.

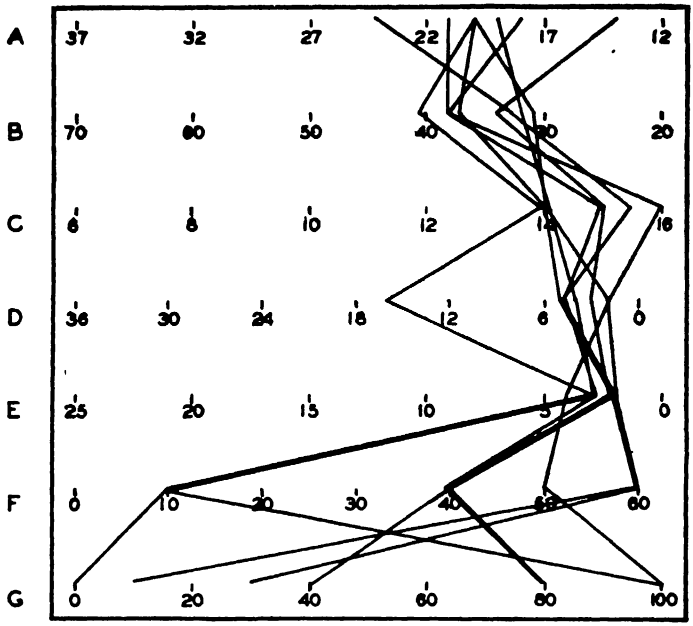
Guatemalan Tropical Flints (fig. 5; pl. 11 D, E, F).—

Apparently a considerable number of tropical varieties have been classified under the general category of "Tropical Flints." For the present we are restricting the term Guatemalan Tropical Flints to a fairly homogeneous race of which we have one collection from Mexico, several from Cuba, and a number from Guatemala, principally on the Caribbean side. The cobs are short to medium but proportionately broad and the seeds are small. The kernels are regular in size and shape and the rows are very straight and sulci evident though not very large. The tassel is much larger than in most North American varieties and there are more branches (the average number is over 20) but the rachises are more slender and the spikelets smaller. Condensed internodes are very rare as are also subsessile spikelets, and the tassel branches by comparison with those of most North American corn look more delicate and more regular.

The race is characteristically flint but slight indications of denting are frequently seen. A small cap of white or light yellow is characteristic and there is variation in color.

Guatemalan Big Grains (fig. 6; pl. 11 G, H, I).—

The outstanding characteristic of this race is the shape of the cob, which is large, sub-cylindrical with a more or less conspicuously enlarged base. The rows are usually straight in the cylindrical portion and too irregular to be recognizable in the enlarged portion. In color the race varies greatly, bright colors being the rule. The



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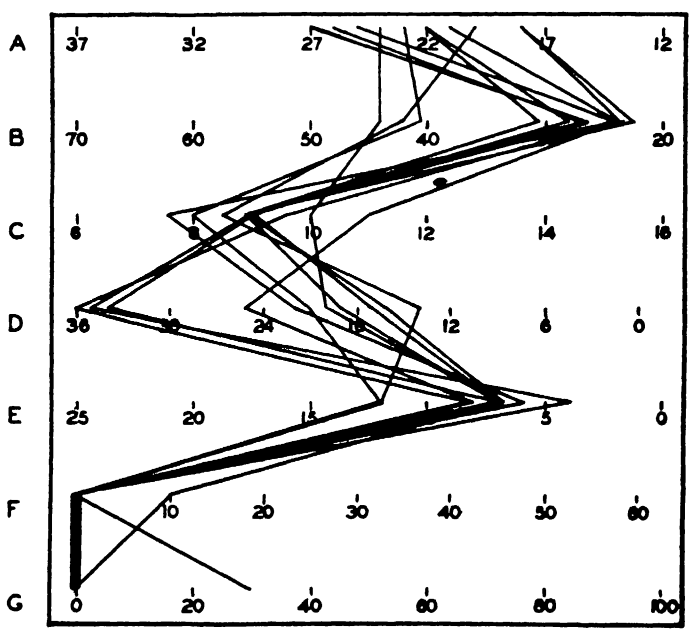

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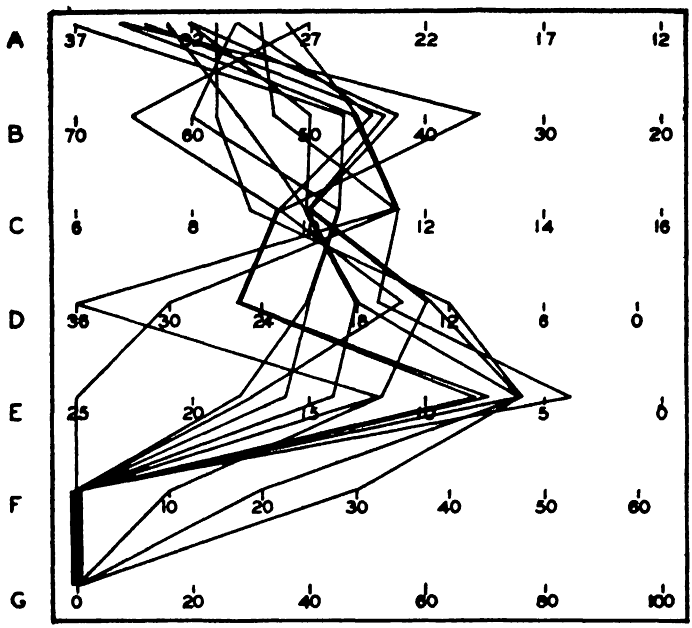
Figs. 4–7. Ear and tassel characters for 5 races of maize: fig. 4, Mexican Pyramidal; fig. 5, Guatemalan Tropical Flint; fig. 6, Guatemalan Big Grain; fig. 7, Racial averages (GBG, Guatemalan Big Grain, PP, Pima-Papago, GTF, Guatemalan Tropical Flint, MP, Mexican Pyramidal).



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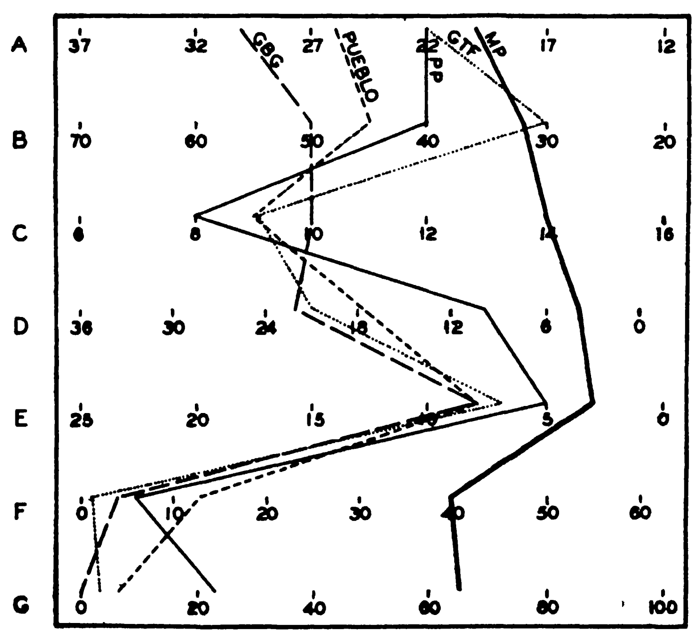

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In figs. 4–6 each line represents an individual plant and shows its value for 7 different characters as follows: A, median cob width in cm.; B, kernel width × thickness in sq. mm.; C, kernel length in mm.; D, number of tassel branches; E, length of sterile zone in mm.; F, % greatly condensed internodes; G, % sub-sessile spikelets.

majority are flints though we have some flour varieties and a number of semi-dented flints. The tassels are similar to those of the Tropical Flints but are even larger and, in our material at least, were characterized by their lax drooping habit. They tend to have very long sterile zones at the base of the branches even up to 10 or 20 cm. in length. The only plant to show subsessile spikelets had already been suspected on ear characters of having been crossed with a Mexican Pyramidal. Condensed internodes are occasionally seen, but, on the whole, the tassels look very much like those of the Tropical Flints as defined above.

Pima-Papago.—

With very few exceptions these varieties are either white or a bright light yellow. Flour corn is the rule, though flints are occasionally found, while denting is unknown. The kernels are small but the cob is proportionately even smaller. This is particularly noticeable at the base. The ear tapers slightly, usually toward both ends, and there is evidence of compression in the narrow base and in lengthwise striations across the kernels. The inner husks are proportionately wide. While the rows are often straight, the individual seeds vary so much in shape that when looking at an ear one notices the kernels rather than the rows. For this reason they look more or less like tiles in a pavement and we have used the term "mosaic-seeded" to describe this effect. The tassels are stiff and harsh and though of medium size have very large glumes. While sub-sessile spikelets are not as common as in Mexican Pyramidal corn, about a tenth of the internodes usually show them. Condensed internodes also occur, though less frequently. As was stated above, these varieties are grown by the agricultural Indians of the deserts near the delta of the Colorado, the Pima, Papago, Yuma, etc. To archeologists this maize is of particular interest because it is very similar to the prehistoric Basketmaker corn which is the oldest recognized type of corn in the Southwest. The habit of the plant is distinctive. Compared to corn-belt dents the stem is slender and the internodes are long for their width, as are also the leaves. Tillers are usually sub-equal with the main stalk.

Pueblo.—

This race is very different from the above and is apparently allied to the Big Grains of Central America. It is characteristically big-cobbed and big-shanked. The ears are long and straight-rowed and the sulci are distinct. While the kernels are by no means so

wide as those of the Central American Big Grains, they are larger than the Pima-Papago and more regular. The base of the ear is usually square or sightly rounded though an enlarged base is occasionally seen. The kernel is either flour or flint and a very faint semi-dent is quite common. The kernel is usually colored, and most white varieties show obvious influence of Pima-Papago in other characters beside color. The tassel is larger than that of the Pima-Papago race with nearly twice as many tassel branches on an average but with slightly smaller glumes. Sub-sessile spikelets are rare but nearly every tassel shows irregular internodes and about one out of ten is obviously condensed. Some plants have a peculiar growth habit. The internodes tend to be short and the leaves wide. The tassels are not greatly exserted and the ears are long, giving the whole plant a curious "squatty" appearance.

SUMMARY

The need of a modern natural classification for the kinds of maize is discussed. Natural and artificial classifications are contrasted and illustrated by simple examples. It is pointed out that each has its advantages and disadvantages; artificial classifications are simple and comprehensive but do not integrate a large number of facts; natural classifications are often difficult to make and cumbersome to use but when they can be achieved they integrate the maximum number of facts.

The difficulties of grouping *Zea Mays* into natural races and subraces are discussed. For the purpose of this paper a race or subrace is defined as a number of varieties with enough characters in common to permit their recognition as a group; in genetical terms it is a group with a significant number of genes in common.

The external morphology of the corn plant is outlined with reference to those characters which might be used as criteria for the recognition and description of race, and the application of these criteria to the classification of maize is illustrated by examples. Indian varieties of maize from the Southwest belong to two main races, the Pueblo and the Pima-Papago, with a few recent admixtures and some obvious intermediates. The first of these races is grown chiefly by the Pueblo-dwelling Indians of the plateaus, the second by desert peoples near the delta of the Colorado River. The latter is very similar to the corn of the prehistoric Basketmakers.

Three Central American groups are described and illustrated,

though their exact relationships are as yet uncertain: (1) the Guatemalan Big Grains, (2) the Guatemalan Tropical Flints, and (3) the Mexican Pyramidals. The last is of particular interest because of its association with the territory of the Aztecs and its relation to modern corn-belt varieties.

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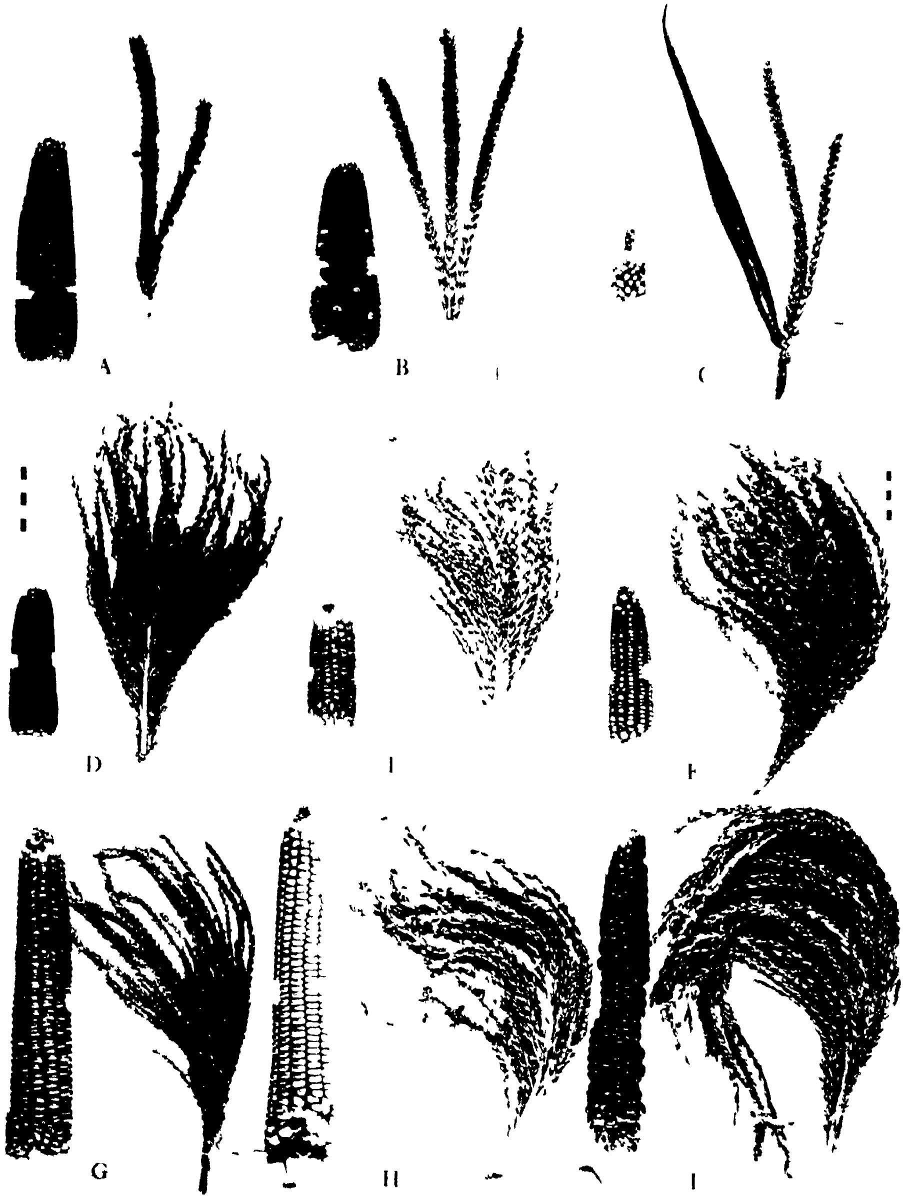
EXPLANATION OF PLATE

PLATE 11

Photographs of ears and tassels *(to different scales)* of representative plants of three races of maize, as follows: upper row, Mexican Pyramidal; middle row, Guatemalan Tropical Flint; bottom row, Guatemalan Big Grain. The ears were collected by Cutler at the points listed below, and the tassels are from seeds taken from the ears and grown at College Station, Texas, and Cienfuegos, Cuba. Except in one instance (E on the plate), the tassel associated with each ear was grown from seed taken from that particular ear. The ears have been somewhat mutilated in measuring mid-cob width. The scales in the center of the figure each represent 5 cm.; the scale to the left is for the ears, the one to the right for the tassels.

Figure	*Cutler's collection number*	*Source of ear*	*Number of ear from which tassel was grown*	*Place at which tassel was grown*
A	42	Xochimilco, Mex.	42	College Station
B	45	Xochimilco, Mex.	45	College Station
C	2	Toluca, Mex.	2	College Station
D	61	El Progreso, Guat.	18	College Station
E	18	Joyabaj, Guat.	18	Cienfuegos
F	24	Chicaj, Guat.	24	College Station
G	16	Coban, Guat.	16	College Station
H	5	Quiché, Guat.	5	College Station
I	6	Chimaltenango, Guat.	6	College Station



ANDERSON AND CUTLER—RACES OF ZEA MAYS

DOLOMITIC GLADES OF EAST-CENTRAL MISSOURI

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A characteristic feature of the landscape of the Ozarks is the occurrence on south- and west-facing hillsides of barrens which are locally known as "glades" or "cedar glades." Such glades, occurring on outcrops of thin-bedded dolomite or dolomitic limestone, principally of lower Ordovician age, have been studied in the area shown on the map (fig. 1). It includes about three-fourths of Jefferson County and small parts of adjacent Franklin, Washington and Ste. Genevieve Counties, Missouri, and lies from 25 to 50 miles west, southwest and south of the city of St. Louis, on the northeastern border of the Ozark Plateau.

The unique character of the Ozark glades has long been recognized by botanists, though no extended accounts have been published. Discussions may be found in the papers on the Ozark flora by Palmer ('21) and by Steyermark ('34; '40), who consider them as relics of the former plains flora of the region. References to the glades may also be found in the geological and geographical literature (e. g., Weller and St. Clair, '28; Pike, '28; Sauer, '20; Cozzens, '37; '39).

The present study is largely a by-product of two other investigations, by Brenner and by Erickson. Brenner's interest in the glades grew out of his study of the environmental variables at the Gray Summit Arboretum of the Missouri Botanical Garden (Brenner, '42). Erickson is engaged in a study of the distribution of *Clematis Fremontii* in Missouri, and the detailed mapping of the glades was done primarily as preliminary work for that study. Wraight became interested in the problem for its geographical and ecological implications. The analysis of the physical characteristics of the glades which follows is largely due to the field work of Brenner and Wraight.

This paper is primarily descriptive, but an attempt has also been made to analyze the factors which are responsible for the occur-

rence of the glades and for their characteristic physical conditions. Although a detailed treatment of the flora is beyond the scope of the present paper, the following remarks may be made. The glades are sometimes completely treeless, but more often there are "islands" of small trees surrounding gullies or ledges of rock. The species most frequently found are:[1] *Juniperus virginiana, Quercus Muhlenbergii, Q. stellata, Celtis pumila, C. pumila* var. *georgiana, Acer saccharum* var. *Schneckii, Rhamnus caroliniana, Vitis Lincecumii* var. *glauca, Cornus florida* and *Bumelia lanuginosa.*

Most characteristic of the glades, however, are the herbaceous species. A partial list includes: *Andropogon provincialis, A. scoparius, Panicum virgatum, Sporobolus heterolepis, Bouteloua curtipendula, Allium stellatum, Nothoscordum bivalve, Agave virginica, Arenaria patula, Clematis Fremontii, Draba cuneifolia, Leavenworthia uniflora, Baptisia vespertina, Psoralea esculenta, Petalostemum purpureum, Croton capitatus, Euphorbia corollata, Viola pedata, Oenothera missouriensis, Polytaenia Nuttallii, Asclepiodora viridis, Acerates viridiflora, Heliotropium tenellum, Scutellaria parvula, Houstonia angustifolia, Solidago Gattingeri, Aster oblongifolius, Silphium laciniatum, S. terebinthinaceum, Rudbeckia missouriensis, Echinacea pallida* and *Coreopsis lanceolata.*

Although the grass cover of the glades is rather sparse, usually consisting largely of separated clumps of *Andropogon,* the grass is the most conspicuous of the herbaceous plants (fig. 4). Despite the grassy appearance of the glades during most of the year, there are a number of other plants which, during their blooming periods, cover the glades with solid masses of flowers. Such plants include both annuals like *Leavenworthia uniflora,* which flowers in April, and perennials such as *Rudbeckia missouriensis,* which carpets the glades in late July and early August. The glade species are all more or less xerophytic, and a number of them are remarkable for their linear or finely divided leaves.

In mapping the glades, use was made of the aerial photographs on file at the offices of the county Agricultural Conservation Associations. The photographs were taken at an altitude of about 13,000 feet and are printed to a scale of 8 inches to a mile. Most of them

[1] The list of species given here agrees with Palmer and Steyermark's ('35) catalogue, although the authors realize that, in some instances, that work is not up-to-date in nomenclature.

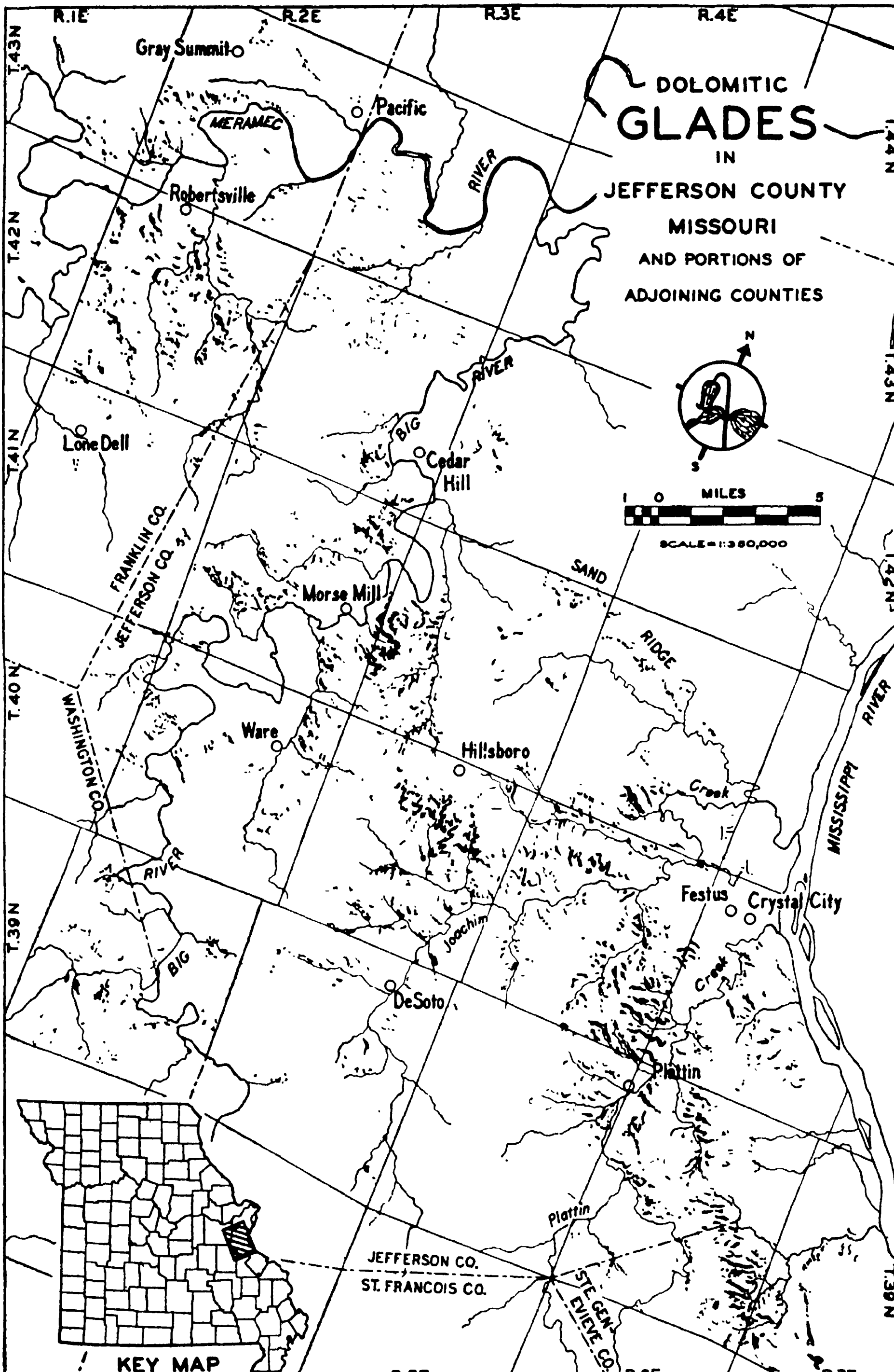
DOLOMITIC
GLADES
IN
JEFFERSON COUNTY
MISSOURI
AND PORTIONS OF
ADJOINING COUNTIES
N
S
1 0 MILES 5
SCALE=1:380,000
R.1E
R.2E
R.3E
R.4E
R.5E
R.6E
R.7E
T.43N
T.42N
T.41N
T.40N
T.39N
T.44N
Gray Summit
Pacific
MERAMEC
RIVER
Robertsville
Lone Dell
BIG
RIVER
Cedar Hill
FRANKLIN CO.
JEFFERSON CO.
Morse Mill
SAND
RIDGE
WASHINGTON CO.
Ware
Hillsboro
Creek
RIVER
BIG
Joachim
Festus
Crystal City
MISSISSIPPI
RIVER
Creek
DeSoto
Plattin
Plattin
JEFFERSON CO.
ST. FRANCOIS CO.
STE. GENEVIEVE CO.
KEY MAP

FIGURE 1

were taken in September, 1937. Glades can be recognized rather easily on the photographs by their whiteness, and they can be distinguished from other white areas, such as bottomland pasture, by their characteristic outline, by the islands of red cedar which occur in most of them, and, in the larger glades, by ledges of resistant rock which give the appearance of contour lines. For each square mile within the area, a tracing was made showing the outlines of glades and some other features such as roads and creeks. The map (fig. 1) was drawn from the photo tracings on a base taken from the county highway maps published by the Missouri State Highway Department. All the glades were drawn as accurately to scale as possible. The drainage was drawn in from the photo tracings and the topographic maps of the U. S. Geological Survey. The map has been checked by field work to some extent throughout the area and rather completely in a few places. The errors are confined to the smallest glades, since it is somewhat difficult to make a distinction between very small glades and hillsides with a rather open cover of red cedars.

The glades in this region almost invariably occur on south- and west-facing slopes. They rarely extend over the top of a hill or ridge and are never found in a valley bottom. The soil mantle is extremely thin, very often less than one inch deep, and there are always numerous flat fragments of the bed rock strewn on the surface (fig. 4). The ground-water relations of the glades are characteristic. During late autumn, winter and spring they are typically so saturated that there is almost continual seepage, and such plants as *Nostoc terrestris* and *Isoetes Butleri*, members of normally aquatic genera, flourish. This saturation leads to a great deal of disturbance from frost heavage when the ground thaws in the spring. During the summer months, on the other hand, the glades are extremely xeric, and for a period in the middle of the summer very little green may appear.

The conditions determining the topographic position of the glades, their unusual physical characteristics and their peculiar flora represent a rather complex interplay of factors such as angle of slope, thin soil mantle, attitude to the sun's rays, and meteorological conditions, as well as the composition and physical characteristics of the underlying rock.

The geological relations of the glades are quite evident from a study of their distribution. Formations of upper Cambrian and

middle and lower Ordovician age outcrop within the area of this study, the geological column being as follows:[2]

Ordovician	Mohawkian	Kimmswick	
		Decorah	
		Plattin	
	Big Buffalo	Joachim	Included within the glade area of this paper
		St. Peter	
		Everton	
	Canadian	Powell	
		Cotter	
		Jefferson City	
		Roubidoux	
		Gasconade	
Cambrian	Ozarkian	Eminence	
		Potosi	
		Derby-Doerun	
		Davis	
		Bonneterre	

These formations present some lithologic contrasts, including a variety of sandstones, limestones, shales and dolomites. The dolomites are of particular importance, since the presence of thin-bedded, relatively non-cherty dolomite (fig. 5) appears to be the decisive factor in the production of glades. The largest glades occur on the outcrop belt of the lower part of the Powell formation, which includes the greatest thickness of such rock in the column. Similar dolomitic strata are found in the Joachim formation, the upper portion of the Everton, the Cotter, the Jefferson City and perhaps in all the other formations listed above except the St. Peter sandstone, the Roubidoux formation and those formations above the Joachim. The largest and most numerous glades, as stated above, occur on outcrops of the lower Powell.[3] The Cotter and Jef-

[2] The geological column is reproduced from the Geological Map of Missouri, with the omission of formations absent from the area of this study.

[3] The formations of the Canadian Series are notoriously difficult to distinguish in the field. They vary greatly in lithology within short distances, both vertically and horizontally, and fossils are difficult to find. The geological correlations of the glades made in this paper are based upon the geological map accompanying Pike's ('28) dissertation on the Crystal City quadrangle, which agrees in interpretation with the map of Ste. Genevieve County of Weller and St. Clair ('28); on personal conversation with Mr. James S. Cullison; and on such field identification by the authors as was possible.

Cozzens ('37; '39) has correlated the glades with the Cotter formation. While the Powell is the most important glade-producer in the southern part of the area described

ferson City, which, with the Powell, constitute the Jefferson City group of the state geological map, are next in importance as glade-producing formations. Small glades are found frequently on the Joachim; the location of the St. Peter-Joachim escarpment (Sand Ridge) is indicated in fig. 1 by the glades on this formation. The Everton is of slight importance in this study. The Gasconade, Eminence and Potosi formations are not important, but small glades apparently occur occasionally. The numerous small glades in northeastern Washington County (T.39N, R.3E) are found on the Derby-Doerun. Glades are reported to occur on the Bonneterre formation (Sauer, '28, pl. III a), but its outcrop lies outside of the area investigated.

In the area of the Plattin and Kimmswick outcrops, south-facing slopes have a sparse tree cover in which red cedars often predominate, and in some places there are few, if any, trees. However, such slopes in the Plattin and Kimmswick country are much steeper than in the area of this study, and there is no thin-bedded dolomite. Where the hillsides are barren enough to justify the term glade, the appearance is quite different both floristically and lithologically from the dolomitic glades. Glades occur on the St. Peter sandstone which also support a different flora from that of the dolomitic glades.

Besides the lithologic character of the rocks, a second factor determining the areal distribution of glades is the amount of local relief. The glades lie almost wholly within the Mississippi and Missouri River Border Provinces defined by Sauer ('20, fig. 18), which are equivalent to the River Border Region of Cozzens ('39, fig. 4). The region as a whole is one of moderate relief for the Ozarks, values of 300 to 400 feet being given by Cozzens, but there is, of course, considerable variation within the region. Glades seem to occur only where the proper lithologic conditions are found in conjunction with relatively high local relief. For instance, reference to the map will show that there are practically no glades between Hillsboro and Sand Ridge. This area is underlain by the same thin-bedded dolomite which elsewhere produces glades, but the relief is not sufficient to allow their development here. In the southeastern part of T.40N, R.5E, one to three miles north of the

here, the only part for which a large-scale geological map is available, the glades are by no means limited to the Powell. Considering the variability of the Jefferson City group from place to place, the Cotter formation may very well be the most important glade-former elsewhere.

Fig 2 Glade on lower part of the Powell formation one mile north of Plattin (SE ¼, S 36, T 40N, R 5E). All the photographs were taken in January, 1942

Fig 3 Severely grazed glade, 2½ miles southeast of Hillsboro (NE ¼, S 14, T 40N, R 4E)

Fig. 4. Portion of the glade shown in fig. 2.

Fig. 5. Recent road cut near Hillsboro, showing thin-bedded dolomite of the kind on which glades occur.

village of Plattin, on the other hand, where rock of the same lithology underlies land dissected by tributaries of Plattin Creek, glades occur on every ridge.

Much of the rock scattered on the surface of the glades is soft and friable, and is called "cotton rock" by residents of the Ozarks. Samples from several localities were tested for dolomite content by the method described by Brenner ('42, p. 104), with results indicating a very high proportion of dolomite crystals. Porosity tests showed about 25 per cent pore space, as compared with values of 3 to 9 per cent for massive dolomite and limestone from the same localities, and 10 to 12 per cent for sandstone.

Soil tests made on the glades at Gray Summit (S.17, T.43N, R.2E) indicated a slight acid reaction and a high organic content. There is very little material corresponding to the leaf litter of the adjacent woods, and the high organic content should probably be ascribed to slow decomposition rather than abundant supply of organic material. This is related to the meager soil flora and fauna, which is in turn due to the extreme variations in temperature and moisture conditions of the glades. It is probable that the amount of available plant nutrients in the glade soil is low, though no attempt has been made to investigate this point.

Probably more important than the chemical composition of either the rock or the soil is the thin-bedding of the dolomite (fig. 5). The beds vary from a fraction to three or four inches in thickness, and contain numerous vertical joints. The presence of bedding planes and joints, along with the extreme porosity of some of the beds, results in ample space for subsurface water. The thin-bedded strata which outcrop in the glades are typically underlain by relatively impermeable massive strata, usually dolomitic, which check the downward percolation of water. This water moves laterally along the numerous bedding planes and, since there is no soil mantle to diffuse it, there is abundant seepage at the outcrops from late autumn to early summer.

Pluvial conditions are also important in the saturation of the glades during the winter and their desiccation during the summer. The mean annual precipitation in this region is about 43 inches. On the whole, the greatest part of this falls during the summer, and the least during the three winter months. At Union, which can be taken as typical of the glade area, since it is only about three miles west of the area included in the map, there are two peaks of

4.54 inches in May and 4.70 in August, and a minimum of 2.20 inches for February. The effective precipitation for the glades, however, presents a somewhat different picture. During the winter and spring months, the rhythmic succession of cyclonic storms brings some sort of precipitation at least once a week. This is usually in the form of a slow drizzle resulting in relatively high infiltration and low run-off, hence much water passes underground. Furthermore, little water is lost by evaporation because of the relatively low temperature and high humidity during such periods of precipitation. This saturation may be an important factor in excluding species of the upland climax from the glades by encouraging winter rotting.

During the summer, on the other hand, precipitation is very irregular and in the form of violent, erratic thunderstorms, separated by longer or shorter periods of drought. During such storms the volume of water falling in a given period is great, runoff is excessive and infiltration is low, hence little water goes underground, particularly on the glades where the soil mantle is thin. The high temperature and low humidity which often follow such thunderstorms further reduce the effective precipitation. Again, the thin soil of the glades contributes to their xeric condition in the summer. A thick layer of soil normally forms a mulch which retards evaporation of subsurface water. The lack of such a mulch on the glades makes for rapid desiccation during warm weather.

The angle of slope of the glades is relatively steep and it appears to be an important factor in determining their characteristics. The slope of a few large glades has been measured by hand-leveling and pacing. There is considerable local variation in gradient at different levels, which can be ascribed to the presence of strata of different resistance, but the average slope appears to vary from 15 to 20 per cent, while that of adjacent north-facing wooded slopes approximates 10 per cent. This steep gradient permits even small volumes of water washing down the slope to carry a considerable load, and is probably one of the principal reasons for the thin soil cover. The steep slope of the glades, coupled with their southern and western attitude, gives them a high angle of incidence to the sun's rays during the warmest part of the day. The attitude of the glades also exposes them to the drying effect of the prevailingly southern winds of the Ozark region.

In the opinion of the writers the dolomitic glades of this area

are permanent ecological entities, entitled to be called an edaphic climax, rather than the first stage in the succession leading to a sugar maple-white oak climax, as they have been regarded by Steyermark ('40, p. 372 et seq.). The fact that open grassland was formerly much more extensive in the Ozarks, and that, with the white settlement of the country and the accompanying reduction of fires, there has been a widespread invasion of the grassland by forest, is too well documented to be doubted. However, the extensive Ozark grasslands of the early nineteenth century occupied hill and ridge tops, where glades rarely occur, and there is no reason for believing that they owed their existence to any more permanent factor than the annual fires which were encouraged by the Indians and early settlers. The dolomitic glades described here, however, seem to present too extreme a set of environmental factors to permit their invasion by trees of the upland climax of this region. The glades seem to be so largely determined by the character of the geological substrate that it would appear to require a rather large-scale change in climatic conditions to obliterate them.

Many of the glades are subjected to grazing by cattle, and to a lesser extent by hogs. Grazing naturally aggravates the barrenness, and occasionally the overgrazing is so severe that practically no plant cover remains. At best the glades produce poor pasture, and a considerable proportion shows no evidence of grazing. It does not seem probable, from a comparison of grazed and apparently ungrazed glades, that they owe their existence to grazing. On the contrary, moderate grazing seems to encourage the appearance of red cedars.

It has been pointed out above that glades occurring on the St. Peter sandstone and on the Plattin and Kimmswick formations differ considerably in character from the dolomitic glades. Barrens are also found on the La Motte sandstone, and in granitic, porphyritic, and highly cherty areas of the Ozarks (Steyermark, '40; Palmer, '10). None of these have been investigated by the present writers, but they should probably all be distinguished from the dolomitic glades of this study.

The glades of this area bear resemblances to the glades and bald knobs of the White River region of Missouri and Arkansas, and to the cedar glades of the Nashville Basin in Tennessee (Harper, '26; Freeman, '33). Relations may also be pointed out between the flora of the glades and that of the Great Plains. The shale barrens

of Virginia and West Virginia (Wherry, '30; Core, '40) appear to represent a similar geologically determined habitat, and they have some floristic similarities to the glades in this area.

Acknowledgments are due the following persons for valuable assistance and criticism: Prof. Edgar Anderson, Prof. L. F. Thomas and Prof. Courtney Werner, of Washington University, Dr. Julian A. Steyermark of the Field Museum of Natural History, Prof. James S. Cullison of the Missouri School of Mines, Mr. H. S. McQueen of the Missouri Geological Survey and Dr. Norman Hinchey, formerly of the Missouri Geological Survey. Mr. McQueen has generously given us access to valuable unpublished maps. The writers are also indebted to the staffs of the Jefferson, Franklin, Washington and Ste. Genevieve County Agricultural Conservation Associations, particularly Mr. Wayne O. Killion of Jefferson County, for their generosity in permitting study of the aerial photographs.

SUMMARY

This paper is a description and analysis of a characteristic type of Ozark vegetation, known locally as "glades," which occur on outcrops of thin-bedded dolomite. A brief enumeration of the flora and a detailed map of these glades for an area in east-central Missouri are presented.

The areal distribution of the glades is determined by geological factors and local relief. Their environmental characteristics, most important of which are winter saturation and summer desiccation, are ascribed to a complex of factors, including thin-bedding of the dolomite, thin soil mantle, steepness of slope, and attitude to the sun's rays.

The glades are regarded as an edaphic climax rather than as a stage in the succession to forest climax.

The relation of the glades to similar vegetational areas elsewhere is discussed.

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THE ENVIRONMENTAL VARIABLES OF THE MISSOURI BOTANICAL GARDEN WILDFLOWER RESERVATION AT GRAY SUMMIT[1]

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INTRODUCTION

Included in the 1,296-acre tract representing the Arboretum of the Missouri Botanical Garden is a parcel of land, roughly 300 acres in extent, which has been set aside to be developed as a wildflower reservation. Here the native trees, shrubs and herbs peculiar to the various natural habitats will be brought together where the public can readily become acquainted with them. Here also rare or otherwise uncommon indigenous wild plants will be held safe from extinction by the hands of the predatory tourist.

It is the purpose of this paper to present a preliminary survey of some of the more important factors conditioning the various environments represented in the Wildflower Reservation of the Missouri Botanical Garden in order that its development may be carried on in a systematic manner. It is hoped that this investigation, despite its strictly elementary nature, will indicate the more important factors to be studied specifically and critically at some future date. An attempt will be made also to correlate the extant arboreal vegetation with the various environmental factors in order to arrive at bases for interpreting the distribution of the native flora. In the course of this study the geology, physiography, soils, and climatology of the area were investigated and the alteration of the flora by the activities of man was reviewed.

For the purpose of this study an area was selected which embraced the various habitats characteristic of the reservation as a whole. The area chosen is bounded on the north by a service road commonly known as the Ridge Trail, on the south by a line connecting the face of the cliff terminating Cliff Ridge to the east with the ledge terminating Ledge Ridge to the west. A line drawn down the

[1] An investigation carried out in the Graduate Laboratory of the Henry Shaw School of Botany of Washington University, under the direction of Prof. Lewis F. Thomas and Dr. Edgar Anderson, and submitted as a thesis in partial fulfillment of the requirements for the degree of master of science in the Henry Shaw School of Botany of Washington University.

crest of Cliff Ridge forms the eastern boundary of the area. A similar line drawn down the crest of Ledge Ridge bounds the area to the west.

Geology

The area lies on the northern border of the region of dolomitic limestone rocks which compose the greater part of the northern Ozark plateau. The rocks belong to the Canadian Series of the Lower Ordovician Period.[2] Two formations are represented, the uppermost stratum of the Jefferson City formation, and the Cotter formation.

METHOD OF STUDY

The rugged land-form of the area and the numerous outcrops of the bed rock made the study and accurate mapping of these outcrops comparatively easy. The cliff terminating Cliff Ridge on the east side of the area offered an excellent exposure for studying the stratigraphy. The thickness of the formations and their different phases were accurately measured with tape and plumb line. The rocks outcropping in the ledge that terminates Ledge Ridge on the west and the numerous outcrops of bed rock on either side of the valley dividing the area provided a sufficient number of stations for correlating the areal geology on a topographic map. A transect line was established up the valley, and from this line shorter lateral lines, at right angles, were made to the various points where outcrops occurred. The relative elevations of the different outcrops were obtained by means of a Brunton compass which was also used to measure the angles of the various slopes. Distances were paced off.

Since the two formations represented on the area are essentially dolomitic in nature, the examination of the chemical properties of the rocks was limited to a determination of the percentage of the dolomite crystals in the various formations or in such phases of these as had an apparent bearing on the vegetation.[3]

Early in this investigation it seemed advisable to study the physical properties of the various rocks, particularly those of the glades.

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[2] Weller, Stuart, and Stuart St. Clair. Geology of Ste. Genevieve County, Missouri. Mo. Bur. Geol. and Mines, II, 22: 30–31. 1928.

[3] By polishing a smooth surface on the rock, then staining it with Lemberg's solution or molar copper-nitrate solution $Cu(NO_3)_2$, the dolomite crystals were easily differentiated from the calcite and other calcareous minerals.

Perhaps in such features as porosity and permeability might lie the basic cause for the development of the unique glade flora. The relative porosities of the various rocks were determined by gravimetric methods, using a procedure outlined by Melcher.[4] The permeabilities of the rocks were tested by comparing the depths to which a dye would penetrate in a given period of time. This procedure, though simple and providing little quantitative data, did, however, show the relative extent to which the rocks were permeable to the infiltration of ground waters.

STRATIGRAPHY[5]

The Jefferson City Formation.—The Jefferson City formation forms the lowest rock outcrop of the strata exposed in the area (fig. 1). The uppermost seven feet of this formation are exposed at only two stations, one in the mouth of the valley, the second at the base of the east end of the ledge terminating Ledge Ridge. The fact that this is the lowest of the rocks outcropping on the area has caused it to be covered with talus debris over the greater part of its range. The rock is a dolomitic limestone, for the most part massive, oolitic, and light buff to gray-brown in color. It has a comparatively low porosity, approximately 5 per cent, is quite permeable, and contains 30 per cent of dolomite crystals. No unconformities are evidenced between the Jefferson City formation and the overlying Cotter formation.

The Cotter Formation.—The remaining rocks outcropping on the area belong to the Cotter formation. Unlike the underlying Jefferson City formation, deeply overlain with talus debris, it presents a great areal exposure of bare rock surface. It was suspected that these various outcroppings, because of their different physical and chemical natures, were apt to be of direct influence on the flora. The formation is composed of phases of sandstones and dolomitic limestones. The limestones appear in both massive and thin-bedded phases, the latter being essentially "cotton rock."

The basal phase of the Cotter formation is one of gray to gray-red sandstone 37 feet in thickness. This sandstone, like the final

[4] Melcher, A. F. Determination of pore space of oil and gas sands. Trans. Amer. Inst. Met. Eng. 65: 496–497. 1921.

[5] The geological correlations made in this paper are based on a well log which is on file at the offices of the Missouri Geological Survey.

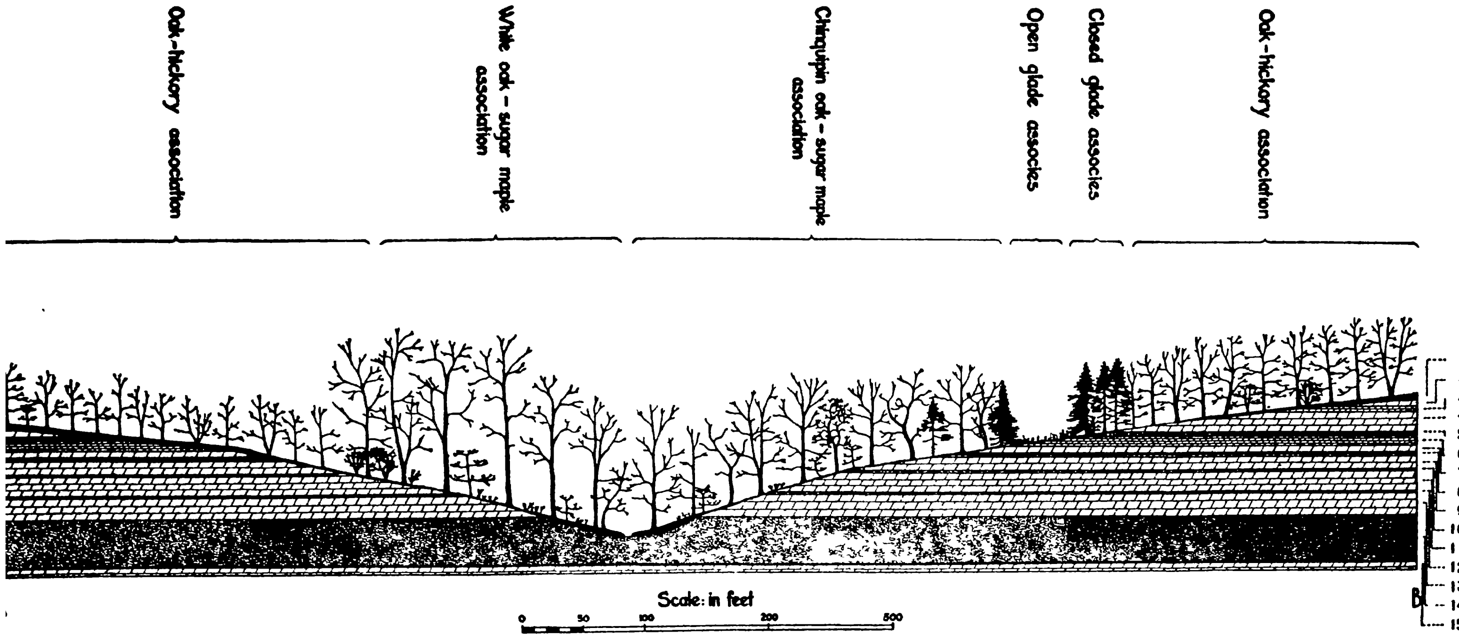

Fig. 1. Structure section through the area A–B (see fig. 2).

1. Soil—silt loam .... Union silt loam
2–14 .... Cotter formation
2. Limestone—massive, dolomitic; 3. "Cotton rock"; 4. Limestone—massive, dolomitic; 5. Sandstone—red; 6. "Cotton rock"; 7. Limestone—massive, dolomitic; 8. "Cotton rock"; 9. Limestone—massive, dolomitic; 10. Sandstone—gray; 11. Limestone—massive, dolomitic; 12. Sandstone—gray; 13. Limestone—massive, dolomitic; 14. Sandstone—gray
15. Limestone—massive, dolomitic .... Jefferson City formation

phase of limestone of the Jefferson City formation which it overlies, is almost entirely covered with a mantle of talus, though numerous small outcrops occur on the valley slopes and in the bed of the wash draining the valley. Overlying this sandstone phase is one of massive limestone 34 feet in thickness and having an intercalation of sandstone about 2 feet thick near its center. Like the higher massive dolomitic phases of the formation, it has a relatively small proportion of pore spaces, 5 per cent, is quite highly permeable, and contains 40 to 50 per cent of dolomite crystals. Chert nodules and lenses, white, brown, to pinkish-blue in color, commonly occur. This phase outcrops in entirety on the face of the cliff at Cliff Ridge, forming a series of high step-like ledges. On the valley walls it has been smoothed off by erosive agents and is overlain by a mantle of chert and float material from strata above. A fine-grained, gray sandstone overlies this massive phase to a depth of two feet and this in turn is overlain by a phase of massive dolomite 9½ feet thick and having a six inch phase of sandstone intercalated four feet above its base. Three feet of thin-bedded dolomite, "cotton rock," overlie this massive phase and in turn are overlain by another five feet of similarly massive dolomite and seven feet of thin-bedded dolomite. The last is typical "cotton rock," pink or buff to gray in color, easily fractured, and in beds from ½ to 4 inches thick. Exhibiting the highest degree of porosity, 24 per cent, of all the rocks occurring on the area, and composed of pure dolomite, $CaMg(CO_3)_2$, together with a very high degree of permeability, it is indeed a most interesting rock. The thin beds are intercalated with very thin lenses of sandstone and a blue-white or pink chert. Rarely, minute intercalations of shale occur between thin beds of slightly argillaceous "cotton rock."

The small remaining portion of the formation has, for the most part, been covered by the Union silt loam which caps the ridges. Outcrops of these higher and final rocks of the formation are not abundant within the area. A few occur at the head of the valley, and some have been laid bare in the construction of the trail on the crest of Cliff Ridge. The latter are thin-bedded, coarse-grained dolomite with thin lenses and nodules of chert. A phase of putty-gray shale six inches in thickness overlies the "cotton rock" and is overlain by a medium-grained, loosely cemented, gray or red-brown sandstone one to three feet in thickness. A five-foot phase of massive faintly oolitic dolomite overlies the sandstone.

TOPOGRAPHY AND RELIEF

The area, essentially rugged, is in the mature stage of the erosional cycle, a feature typical of the hills and ridges bordering the southern face of the area to the north of the Meramec River.[6] Two ridges, Cliff Ridge and Ledge Ridge, truncated by an ancient meander of the Meramec River, rise 140 feet above the flood plain of that river (fig. 2). The cliff terminating Cliff Ridge, together

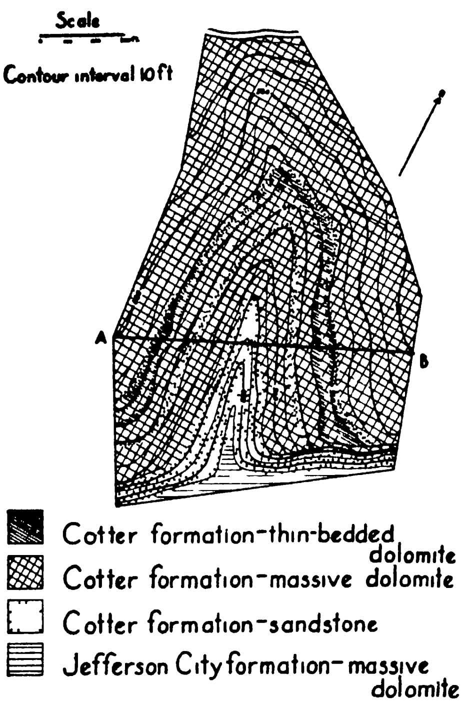

Fig. 2. Geologic map. A–B, location of geologic structure section.

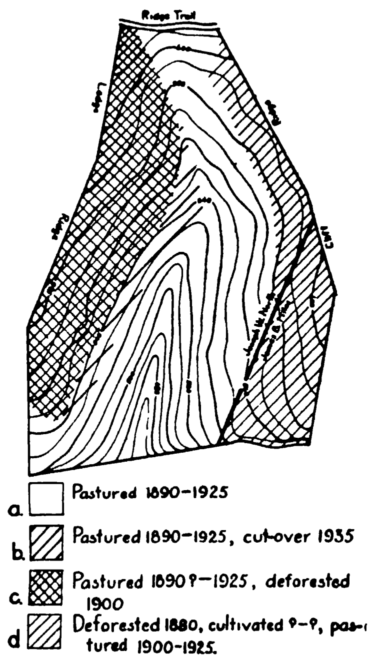

Fig. 3 Showing land use of the area 1880–1935.

with the high ledge facing truncated Ledge Ridge, and the numerous ledges, shelves and other outcrops enhance this rugged nature. A deep valley with a youthful "V" profile bisects the area (fig. 1). During the rainier seasons of the year a rivulet occupies the acute trough of the valley, carrying the waters drained from the adjacent uplands to the flood-plain where they are soon lost in the gravels underlying the silt. The ridges are, for the most part, narrow and appear as lateral spurs from the higher ridge serving locally as the

[6] Marbut, C. F. Soil reconnaissance of the Ozark region of Missouri and Arkansas. U. S. Dept. Agr., Bur. Soils and Field Operations, Rept. 13: 1727–1873. 1911.

drainage divide between Brush Creek to the north and Meramec River.

The area, as a whole, offered an interesting study in angles of slope[7] resulting from differential weathering of the formations and their included phases. A profile of the valley, taken at points A-B (figs. 1 and 2), shows the massive limestone of the Jefferson City formation overlain by the weaker, basal sandstone phase of the Cotter formation and this in turn by the resistant massive limestone. Here the angle of slope is quite high, 15 to 18 degrees, and few outcrops occur since the rock is deeply overlain by soils creeping down from above. This steep angle of slope persists through the massive phases of the Cotter formation where it is broken by the thin-bedded phase of that formation. Here the slope is about 10 degrees. The steeper angle is resumed by the recurrence of the second massive phase of the Cotter, represented in part by a low ledge. The second, thicker of the thin-bedded phases of the Cotter formation causes a conspicuous break in the angle of slope. Here the weakly resistant, thin-bedded rocks have been rapidly beveled off, and the angle of slope is more gentle, 10 degrees. A low ledge marks the thin sandstone phase overlying the "cotton rock," after which an even lower angle of slope, 5 degrees, is assumed and retained to the crest of the ridge.

Soil Survey

The soils of the area have been classified by the United States Department of Agriculture, Bureau of Soils, as belonging to the sandy subsoil phase of the Union silt loam.[8] The report did not consider the smaller, more specialized types of soil, particularly those classified as "rough stony land." Such soils lie on the steep slopes of the ridges immediately north of the Meramec River in the vicinity of Gray Summit. Since a great portion of the area under investigation is covered by such soil, it was found necessary to study its physical and chemical properties to aid in the interpretation of the flora.

METHOD OF STUDY

Samples, weighing about 100 grams, of the upper six inches of the soil were systematically taken at 100-foot intervals across the val-

[7] Cozzens, Arthur B. Analyzing and mapping natural landscape factors of the Ozark province. Acad. Sci. St. Louis Trans. **30**: 37–63. 1939.

[8] Vanatta, E. S., and H. G. Lewis. Soil survey of Franklin County, Missouri. U. S. Dept. Agr., Bur. Soils and Field Operations, Rept. **13**: 1603–1633. 1911.

ley and at 200-foot intervals up the valley. After drying thoroughly in the air they were examined for content of organic matter, relative proportions of different sizes of soil particles, as recognized by the Bureau of Soils, and soil reaction or degree of acidity.

Analysis of Organic Content.—Ten-gram portions of the samples were taken along line A–B (fig. 2). After being weighed, they were heated in a crucible for 30 minutes over a hot Bunsen burner. They were weighed again after cooling, and any loss of weight was considered to be organic material removed by combustion. The results of these operations appear in TABLE I.

TABLE I

MECHANICAL AND ORGANIC-CONTENT ANALYSIS OF THE SOIL ALONG BELT TRANSECT B (see fig. 11)

Sample	% Rock & gravel	% Fine gravel	% Coarse sand	% Medium sand	% Fine sand	% Very fine sand	% Silt & clay	% Organic matter
1	0	0	.73	2.84	4.39	1.99	80.41	9.5
2	7.83	2.85	2.27	3.17	4.37	3.65	64.58	10.8
3	15.62	7.20	3.34	4.81	5.40	6.39	54.06	1.7
4 Glade	59.87	1.91	1.16	2.08	3.41	2.41	43.31	17.0
5	35.57	6.94	2.20	7.13	10.16	4.39	16.94	15.3
6	34.30	1.57	1.27	2.46	6.34	5.87	15.77	31.4
7	39.24	2.16	3.80	2.72	7.41	5.04	19.22	19.9
8	14.85	4.61	4.62	5.99	6.08	5.31	43.85	14.3
9	0	.179	1.61	4.58	4.58	5.024	73.71	10.1
10	0	.93	1.58	3.26	4.37	3.25	79.05	7.0
11	0	0	.85	3.07	4.32	3.36	84.56	3.9

Mechanical Analysis.—An analysis was made of samples taken along line A–B (fig. 2) to show the percentages of the different sizes of soil particles. Fifty-gram portions of the air-dried samples were weighed out. They were then dispersed in a mortar by gently rubbing with a pestle, after which they were shaken successively through a series of screens recommended for mechanical analysis of soils.

Soil Reaction (degree of acidity).—The samples taken over the whole area were tested for soil reaction with Brom Cresol Green,

Brom Cresol Purple, and Phenol Red indicators in a method described by Moore.[9] The results are compiled in fig. 6.

Soil Horizons.—Several test pits were dug at stations covered with a typical flora and suggesting a typical soil type. Where possible the pits were dug down to bed rock, but when the soil mantle was so deep as to make this impractical the approximate depth of the soil was tested by probing into the bottom of the pit with a crowbar. The thicknesses of the various soil horizons were measured and their color, texture, consistence, structure and porosity noted

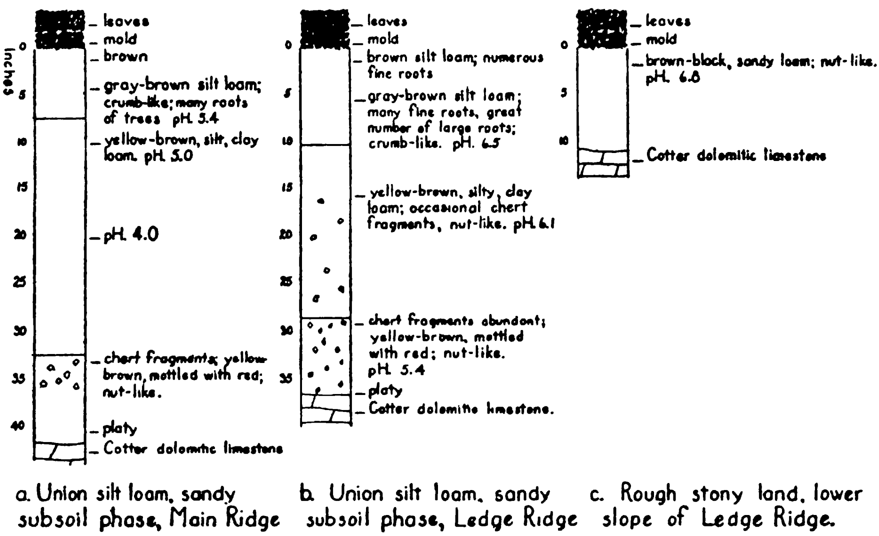

Fig. 4. Soil profiles.

in accordance with recommendations made by Kellogg.[10] Sample profiles of the typical soils are shown drawn to scale in fig. 4.

THE SOILS

As was previously stated, the soils of the area have been classified by the Bureau of Soils into two distinct groups: the sandy-subsoil phase of the Union silt loam, and the "rough stony land."

The Union Silt Loam, Sandy Subsoil Phase.—The Union silt loam, sandy subsoil phase, is a brown or grayish-brown mellow silt loam 6–8 inches deep, which changes at depths between 8 and 20 inches into a light brown or yellowish-brown friable silt loam or

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[9] Moore, W. An improved method for the determination of the soil reaction. Brit. Golf Unions Jour. 4: 136–138. 1935.

[10] Kellogg, Charles E. Soil survey manual. U. S. Dept. Agr. Misc. Publ. 274. 1937.

a silty clay loam. In structure the soil is crumb-like, grading into a nut-like subsoil (fig. 4a & b). Its origin is not perfectly understood, but its uniform nature over broad areas seems to suggest that it is loessial. An interesting character of this soil is the high proportion of fine sand grains (TABLE I). This soil lies as a cap, about 3–3½ feet deep, upon the crests of the ridges. Its loose sandy nature, together with the relatively high angles at which it lies on the slopes, has made it an easy prey to agents of erosion. In places

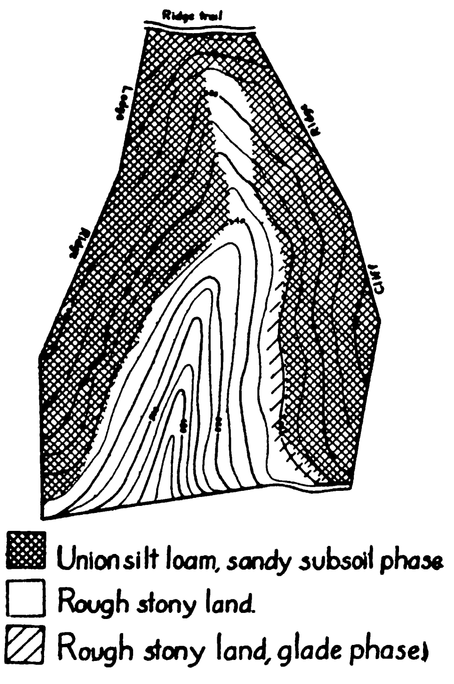

Fig. 5. Soil map.

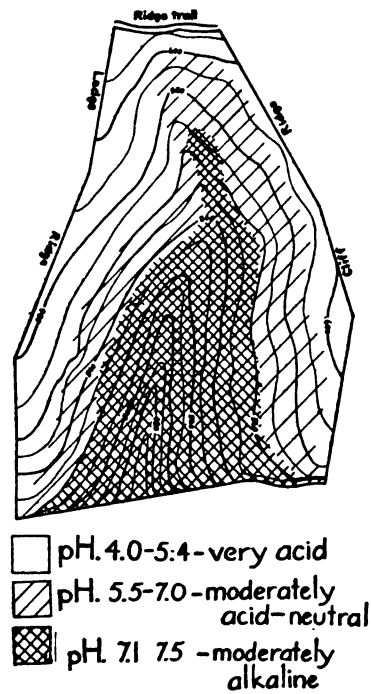

Fig. 6. Showing distribution of different acid-alkaline soil types.

where the plant cover is sparse, as on the east slope of Ledge Ridge, many deep gullies have been eroded into the soil and subsoil horizons.

This soil, when treated with indicators, is found to be consistently very acid, from pH 4.0 to pH 5.4, the degree of acidity increasing as one proceeds to the lower soil horizons (fig. 4a & b). The low pH is perhaps partly due to its sandy, porous nature which has facilitated leaching to a moderate degree. There is also a decided tendency for vegetable litter to collect on the forest floor. It is in those places where the litter has collected to a considerable depth and

where it is predominantly of oaks and hickories, which is relatively slow to decay, that the lowest pH ranges are reached.

The soil shows a low content of organic matter, 1.7 to 10.8 per cent (TABLE I). The majority of the trees are of tap-root nature. Fibrous roots would tend to increase the organic content of the soil, but few such root systems are formed and they are necessarily short-lived. For the most part, few herbs are found on the forest floor on the ridges, and such plants are an important source of humus. Perhaps the poor herbaceous flora may be due to the thick layer of forest litter which prevents seeds and other propagules from reaching a suitable growth medium, particularly since the surface of this litter is dry for the greater part of the time. Also the forest floor is densely shaded during most of the growing season. Animal action in this soil is not particularly great. Comparatively few "signs," castings, burrows, or actual specimens of the more common subterranean animals were found in the course of sampling. The high degree of acidity and the low organic content of the soil might account for the poor fauna.

"Rough Stony Land."—The soil of the "rough stony land" is essentially residual and very shallow, from a mere film to 12 or 14 inches in depth. It is a very dark, brown-black to black sandy loam, plastic when wet, very brittle when dry, and essentially nut-like in structure (fig. 4c). The very shallow depth of the soil has permitted it to mature relatively early, which is indicated by the lack of definite horizons and the abundance of small insoluble fragments of chert. This soil may be considered as a vertically uniform mass. It contains a relatively high per cent of fine sand grains which increase as one progresses towards the valley (TABLE I). It is interesting to note the abundance of oolite composing these sand grains, a feature offering good evidence of the residual origin of this soil, for they have weathered out of the underlying oolitic dolomite rock strata.

This soil differs markedly from the Union silt loam of the ridges in being essentially a basic or lime soil. Soil tests show a pH range from very slightly acid, 6.8 at the uppermost limit, to alkaline, 7.5, in the valley (fig. 6). This soil contains a large amount of organic matter, 14.3 to 31.4 per cent, which increases steadily as one progresses down the slope and reaches its maximum in the valley (TABLE I). The high organic content of this soil, its shallow depth, and the massiveness of several of the underlying rock formations or their phases cause it to be exploited to a high degree by the roots

of trees and herbs. The high organic content makes this soil a valuable reservoir of infiltrated water and as a consequence able to support a rich herbaceous and arborescent flora. Animals are quite active here, numerous burrows, castings, puppae and specimens being noted.

"Rough Stony Land," Glade Phase.—This soil is limited to the glade, formed by the thin-bedded phase of the Cotter formation, on the west slope of Cliff Ridge (fig. 1). It is a very thin (from a mere film to 4 inches in depth) gray-brown silt loam. Soil reaction tests show it to have a pH range from 6.8 to 7.1, an essentially neutral reaction. An interesting feature of the glade soil is its high humus content, approximately 17 per cent. This can easily be understood when one remembers that the glades are of a xeric nature and therefore unfavorable to conditions of decay. The shallow depth of the glade soil and the generally xeric conditions tend too to discourage occupancy by subterranean animals, also important agents in the reduction of organic material.

Climatology of the Area

The geomatic position of the area, between longitudes 90° and 91° West, and latitudes 38° and 39° North, places it in the temperate zone. Here the weather is governed by cyclonic conditions in winter. Local continental thunder-storms prevail in summer. The region has an annual rainfall of approximately 39 inches. The mean annual temperature is approximately 55° F. The last killing frost in the spring usually occurs about April 16, and the first killing frost in the autumn about October 22.

Accurate records of the precipitation on the area were not kept. However, a weather station at Pacific, Missouri, seven miles away, offers data which may be applied with reasonable reliability.[11]

Relatively accurate temperature records were kept on the area continuously for one year, at stations selected for extremes in environment. Thermometers were housed in specially designed shelters three feet above the ground. Comparisons were made of temperatures recorded on the ridge (Sta. A-1) and in the valley (Sta. A-2); on a west-facing slope (Sta. B-1) and an east-facing slope (Sta. B-2); on the open glade (Sta. C-1) and closed glade (Sta. C-2) (figs. 8–10). Temperatures of two-week periods were selected as representative of each season of the year. Unfortu-

[11] Climatological data, Missouri section. U. S. Dept. Agr., Weather Bureau. 1940–1941.

nately, with only two recording thermometers available, continuous records at any one station were not possible, and in order to obtain a recording representative of each season the instruments had to be moved to another station every third week. This fact has prevented the direct comparison of most of the stations at a given time.

Comparison of Temperatures on Ridge (Sta. A-1) and in Valley (Sta. A-2).—In spring the ridge tends to be cooler during the day-

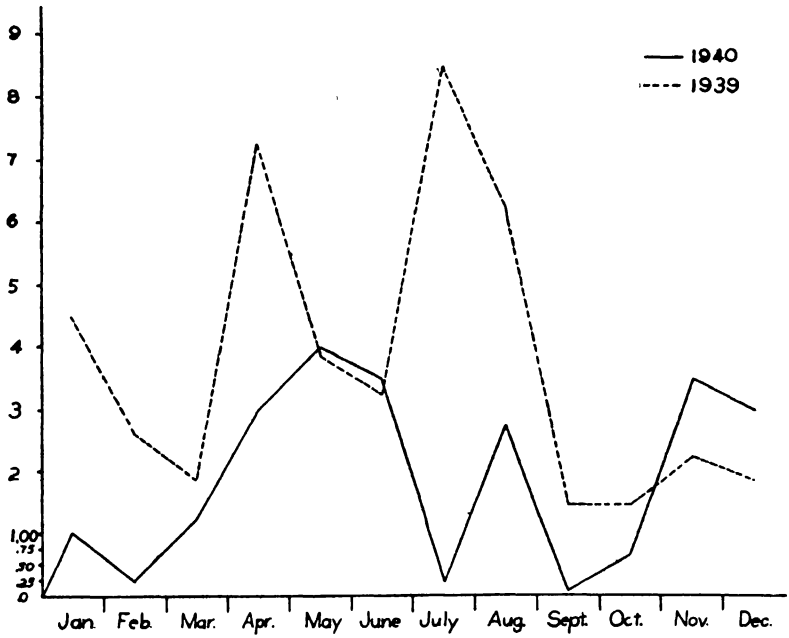

Fig. 7. Showing monthly precipitation in inches, at Pacific, Missouri, during 1939 and 1940.

light hours and warmer at night (fig. 8B). The valley tends to be from 2 to 5° warmer between the hours of 10 a. m. and 2 p. m., and about 1–7° cooler from 6 p. m. to 6 a. m.

In summer the ridge is consistently warmer than the valley (fig. 8C); in the night and very early morning, from 11 p. m. to about 6 a. m., it is usually only 2–4° warmer. For the remainder of the day, the ridge is about 5–8° warmer than the valley, except from 11 a. m. until 2 p. m., when it is only slightly warmer, 0 to 4°. The maximum mid-day temperature occurs at noon in the valley, due perhaps to the fact that after the sun drops several degrees past a vertical position the valley is again shaded by the foliage of the trees. The maximum mid-day temperature occurs at about 2 p. m.

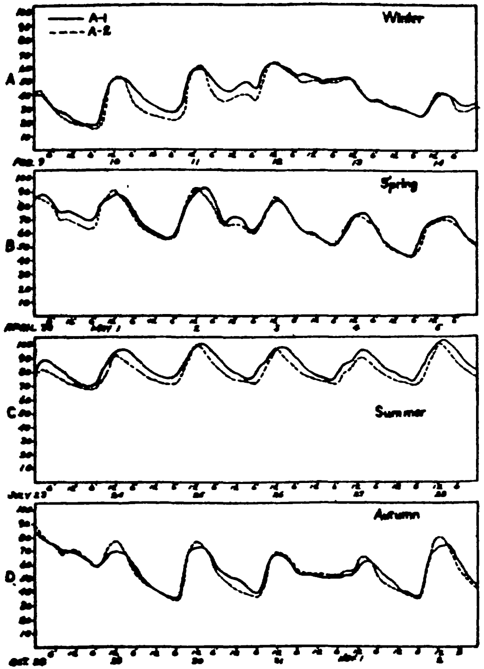

Fig. 8. Graphs of temperatures recorded as samples of seasonal variations between stations A-1 (ridge) and A-2 (valley).

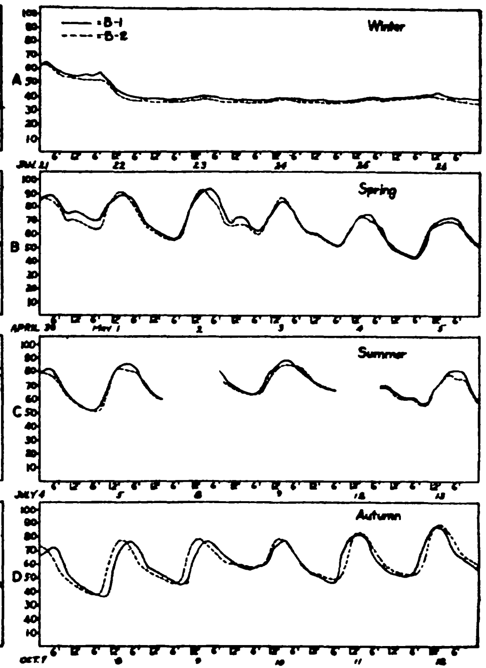

Fig. 9. Graphs of temperatures recorded as samples of seasonal variations between Stations B-1 (west-facing slope) and B-2 (east-facing slope).

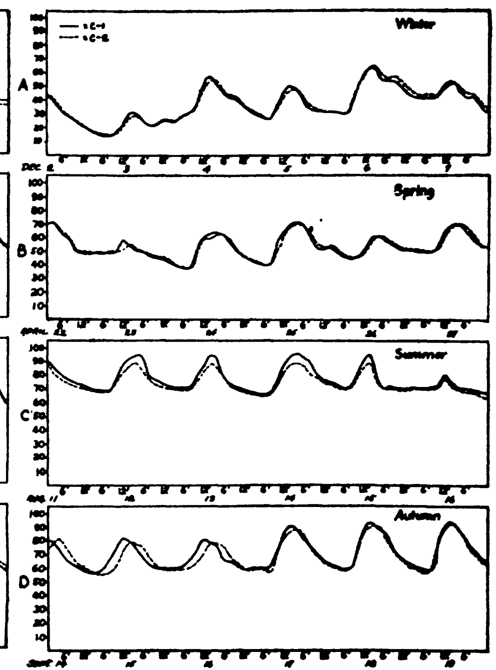

Fig. 10. Graphs of temperatures recorded as samples of variations between stations C-1 (open glade) and C-2 (closed glade).

on the ridge, where even after the sun has fallen from its vertical position it still penetrates through the less dense foliage.

With the approach of autumn and winter, the gradual loss of leaves by the trees permits a proportionately greater penetration of the sun's rays into the woods. It was noticed then that the maximum mid-day temperature in the valley was reached at noon as it was in the spring (fig. 8A and D). Similiarly, as the day temperatures in the valley increased, the night temperatures decreased. This marked difference in nocturnal temperatures is caused by the cooler, denser night air settling in the valley, a phenomenon known as air drainage. Day temperatures here tend to be 5–9° higher than those on the ridge, while night temperatures are 2–4° lower.

Comparison of Temperatures on West-facing Slope (Sta. B-1) and East-facing Slope (Sta. B-2).—In the early spring, autumn, and winter, when the trees are bare, the west-facing slope is strikingly cooler in the morning and very early afternoon, from 6 a. m. to 1 p. m. (fig. 9A, B, D). At this time the west slope was from 2 to 10° cooler than the east slope. During the late afternoon, evening and night the west slope is 2–6° warmer than the east slope. The maximum temperature of the day occurs at about 4 p. m. This rather odd distribution of temperature is caused by the attitude of the western slope to the rays of the sun. Exposed as it is, it is shaded in the morning and it is not until late afternoon that the rays of the sun strike it at a high angle and raise the temperature to the maximum point. At night this slope is somewhat warmer than the east-facing slope. This is because the sparse vegetation, the relatively large amount of exposed rock, and thin covering of mold and forest debris on the west-facing slope permit a great degree of heat radiation at night.

During late spring and summer the west-facing slope is consistently warmer than the east-facing one (fig. 9B and C). In general, the difference is small, only 1–4°, this being due to the relatively greater amount of heat-consuming moisture transpired by the more dense vegetation on the east-facing slope. As in winter, spring, and autumn the maximum day temperatures occur at about 11 a. m. on the east slope and at about 4 p. m. on the west slope.

Comparison of Temperatures on Open Glade (Sta. C-1) and Closed Glade (Sta. C-2).—In winter, early spring, and autumn the open glade is usually 3–8° warmer during the day than the closed glade (fig. 10A, B, D), an obvious condition when one remembers

the barren nature of the open glade. At night during these seasons it is from 1 to 4° cooler than the closed glade where the considerable abundance of junipers tends to make the air more quiet. A denser covering of mold and litter on the forest floor prevents rapid heat radiation which takes place on the barren open glade.

In summer, however, the open glade is constantly warmer than the closed glade (fig. 10C), being from 3 to 8° warmer between 9 a. m. and 7 p. m. and usually 1–4° warmer during the night and early morning. Normally it would be expected that the barren nature of the open glade would favor rapid heat radiation and that it would be cooler than the closed glade at night. However, a canopy of broad-leaved trees cover the closed glade during the growing season, which, together with numerous herbaceous plants on the forest floor, create a more equable climate.

History of the Land Use of the Area

In order to interpret the relatively complex flora inhabiting the area at present it was found necessary to learn the use of the land from facts revealed by the area itself. The history was begun as near as possible from the time when the land was first occupied by the white settlers emigrating from the East up to its present use as a wildflower reservation.

Use was made of data obtained from field notes taken on the area, and of documentary evidence offered by an abstract to the title of the land. Old trees were important sources of information concerning the aspects of the original flora. The younger trees served as indicators of changes in environment during the time that the area has been occupied by white man. A survey and map of tree stumps revealed the age of living trees of like diameter and also provided a definite record of the former use of the land. The abstract to the land title proved valuable by supplying the dates on which the parcels were granted to the first settlers. It also indicated the dates on which the land fell into the hands of the various families and finally the present institution, the Missouri Botanical Garden. The uses to which the various portions of the area were put, together with the time and intensity of use, were compiled in fig. 3.

The area is composed of two parcels of land which have had separate title histories up to the time that the Missouri Botanical Garden acquired them (fig. 3). A small portion of the area, on Cliff Ridge, represents part of an eighth section granted by the United

States to Edward J. Roberts on July 13, 1853. In 1881 it became the property of James B. Miles. The larger portion of the area is a part of the quarter section granted by the United States to William M. McPherson on June 19, 1851. Later the property was transferred to Powell; from Powell to Knapp in 1854; from Knapp to Crews in 1858; and from Crews to North in 1880. On March 12, 1925, both parcels of land were included in the area bought by the Missouri Botanical Garden.

An inspection of the area shows that it has been used in the following four ways, arranged progressively according to the degree to which the practice has altered the vegetation: (1) grazing, (2) light cutting over and grazing, (3) deforestation and grazing, (4) deforestation, cultivation, and grazing.

Grazing.—A survey of the area as a whole revealed it to have been generally and quite intensely grazed over. Though certain of the more ancient typical forest trees, oaks, hickories and maples, show decided preferences in their distribution, many younger specimens have a general distribution suggesting uniform conditions throughout the area. Such trees as red cedar *(Juniperus virginiana)*, slippery elm *(Ulmus fulva)* and redbud *(Cercis canadensis)* are generally distributed and have been noted to invade local forested areas upon the advent of grazing.

Although it is evident that grazing is only one of the factors which have altered the vegetation of the area as a whole, there is a portion, representing slightly less than half the total expanse, on which grazing has been the only altering factor (fig. 3a). This fact is expressed by the total absence of stumps in a tract which contains an appreciable number of very old trees, obviously members of the virgin flora for their trunk diameters are comparable to stumps of trees calculated to be 175 to 260 years of age. These old trees have tall straight trunks and form a high canopy which, however, is broken in many places where individuals have died. Numerous dead specimens and standing "snags" are to be found, and many decaying trunks lie on the forest floor. Judging from the habit of the old trees, the aspect of the virgin forest was, for the most part, more closed and densely shaded. The present light open aspect of the forest suggests that a change of environment has taken place in a relatively short time. Throughout this plot there is a marked predominance of the group of trees referred to earlier in this account as indicative of intensive grazing. Counts of the annual growth

rings of red cedars are perhaps alone the best indicator of conditions accompanying grazing of local forest areas. Several counts were made on trees from different points of the plot, and 30–40 years was found to be the average age. Allowing 10–20 years for grazing to alter the habitat sufficiently to encourage invasion by the red cedar and other heliophilous trees, it becomes evident that grazing was begun here shortly after the land was acquired by Joseph North in 1880. Grazing was practiced over the whole area up to the time that it was bought by the Missouri Botanical Garden.

Light Cutting-over and Grazing.—A small portion of the area, that immediately bordering the old pasture on the east slope of Ledge Ridge and extending a short distance down the slope toward the ravine, was lightly cut over during the period that the Arboretum was maintained by government-supervised transient labor. These recently cut stumps have supplied data concerning the ages of the forest patriarchs, and have offered some idea as to the approximate ages of stumps and trees found elsewhere on the area. The removal of many old trees has produced a poor canopy of foliage and has made the forest here very open, almost park-like. The rich mold on the forest floor has proved to be an excellent seed bed, and a dense thicket-like growth of shrubs and saplings forms a lower stratum of vegetation. In addition to the older trees of the group which have invaded under grazing conditions, many seedlings of these species originated during the period following cutting-over and the resultant increased light on the forest floor (see fig. 3b).

Deforestation and Grazing.—Two portions of the area, which when combined represent approximately half of the whole, have obviously been deforested (fig. 3, c, d). Many stumps are to be found here, all of a uniform age and none from old trees. The cut-over portion represented on Cliff Ridge (fig. 3d) is divisible into two parts, each having been deforested at a different date. The portion representing the land formerly belonging to James Miles was apparently deforested about 60 years ago. Though no trees were cut to obtain counts of annual growth rings, comparison of the trunk diameters with those of other young trees of known age warrants this statement. The stump remains found here are in poorer state of preservation than those of more recently deforested portions, but the diameters of the stumps place the entire former vegetation in the class of virgin flora. When the approximate age of the trees was compared with the title to the land it was found that this por-

tion had been cut over about the time that the land was bought by James Miles.

The second, smaller portion of the deforested area on Cliff Ridge formerly belonged to Joseph North. The annual rings of several of the young trees now growing there were counted and showed the trees to be approximately 40 years old. The stumps, an undeterminable species of oak, found in this portion are in a better state of preservation than those of the trees cut from the Miles property. The age of the trees, together with the better state of preservation of the stumps, indicates this portion to have been more recently cut over than that on the Miles property, some 10–20 years after it was acquired by Joseph North.

It is evident that both portions have been grazed over quite intensely, for numerous islands of red cedar, slippery elm and redbud occur where the live stock succeeded in checking the rapid growth of the encroaching second growth of the forest.

Deforestation, Cultivation and Grazing.—A study of the plot on the east slope of Ledge Ridge (fig. 3c) has shown it to have been deforested and afterwards probably cultivated, for no stumps have been found there. Later on, and evidently for quite a period of time, it was apparently grazed and burned at intervals. A great number of the oaks and hickories now growing on the site exist as clumps composed of two to six trunks. This feature suggests that an old pasture already having a fair growth of seedling trees had been trampled by the hoof of livestock, or burned off, causing the original stem to die and numerous basal sprouts to spring up. The annual growth rings of several of these trees were counted and showed an average of 21. It is known that the site was still maintained as a pasture at the time of its purchase by the Missouri Botanical Garden in 1925. Relatively older trees, 40–60 years old, which border the plot on either side, have low limbs spreading into the clearing, indicating development as marginal trees. This fact places the clearing of this plot shortly after its purchase by Joseph North in 1880.

Vegetation

The arborescent flora is a complex one composed of 28 genera and a total of 40 species. As noted previously, the large number of species and the relatively wide distribution of many of them over the area may, perhaps, be best attributed to human occupation rather than to natural causes.

METHOD OF STUDY

The complexity of the vegetation suggested that rather intensive methods should be applied to its study in order to secure a complete picture of the distribution of all the component genera and their species. A series of five 150-foot belt transects was run across the area at 150-foot intervals in order to obtain a complete and detailed map of the trees and shrubs. Because of the wide range of genera and species represented in the flora, and because of the presence among them of many small trees and shrubs considered as being valuable indicators of various abnormal conditions, practically no attempt was made to divide the flora into size classes on the basis of actual field measurements. However, record of the relative sizes of the various consistently large specimens was kept and is discussed below. Data obtained from these individual maps were arranged in graphical form. The survey of stumps used in the study of the land use of the area has also served in interpreting the relics of the virgin forest flora.

Belt Transects.—The transects were mapped by plotting, in linear fashion, a series of 50-foot quadrats across the area. Three such lines of quadrats were plotted adjacent to one another, thus forming a belt transect 150 feet in width across the area (fig. 11). Individual quadrats were marked with flagged staffs, oriented transverse to the area with a compass. Distances were paced off. The number of each species represented in the quadrat was counted in turn and noted in corresponding quadrats on individual maps. Figures 13–17 show species in each belt transect, together with their respective distributions across the area. Species having a similar distribution have been grouped together.

On the basis of the belt-transect maps and graphs showing the density of each species in the different belt transects, a composite map has been prepared showing the grouping of the species into associations and associes and their areal extent (fig. 12).

The terms, association, associes, and dominant, used in discussion of the vegetation in this study, have been used in the sense originally applied by Weaver and Clements.[12]

DISCUSSION

As stated above, the complex nature of the vegetation of the area is essentially a condition resultant of intensive grazing. Likewise,

[12] Weaver, J. E., and F. E. Clements. Plant ecology, pp. 43–54. New York. 1939.

mention was made of a class of trees locally indicative of pastured forest land. It seems essential at this point to review the succession of conditions leading to the present state of the vegetation of the area.

Judging from the habit of the various scattered ancient forest trees, it is apparent that the aspect of the local forests before the advent of man was, for the most part, open. The trees were widely spaced. The canopy of foliage was quite well developed and gen-

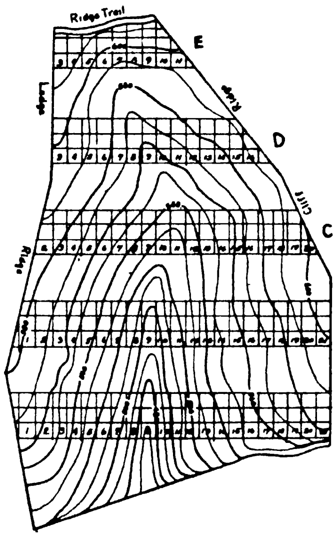

Fig. 11. Showing location of belt transects.

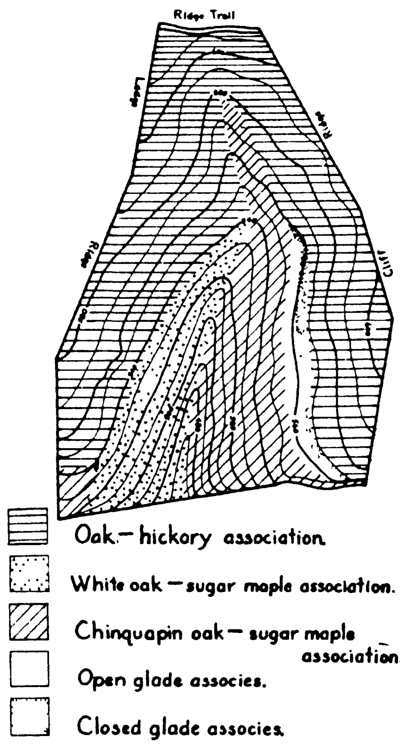

Fig. 12. Showing the tree associations of the area.

erally excluded the growth of a rich herbaceous flora on the forest floor. The forest floor in all probability was carpeted with a thick mat of litter, and a thick layer of humus lay on the soil surface. Such forests, though they may be poor in herbaceous plant material during the summer months, do, however, contain a rich herbaceous spring flora. It is not unlikely that the early landowners took advantage of this fact and turned their stock into the forests in the spring to forage on the fresh, succulent herbs. They were probably also quick to learn that by burning away the thick mat of litter on

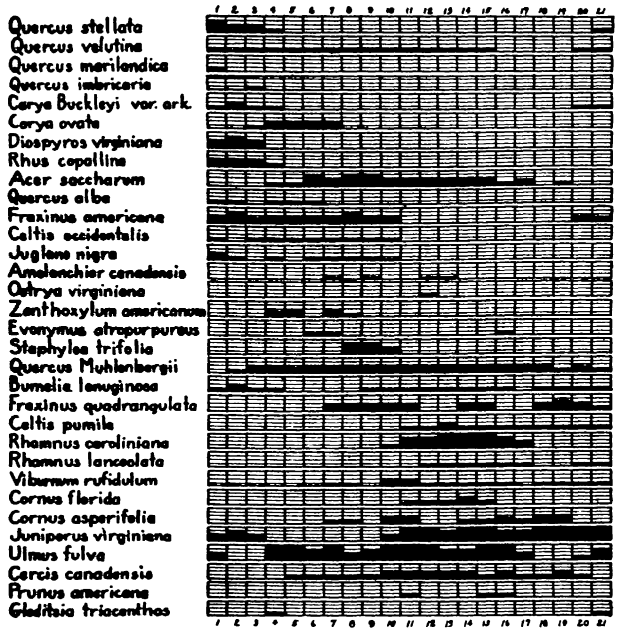

Fig. 13. Showing distribution and density of species in belt transect A (see fig. 11).

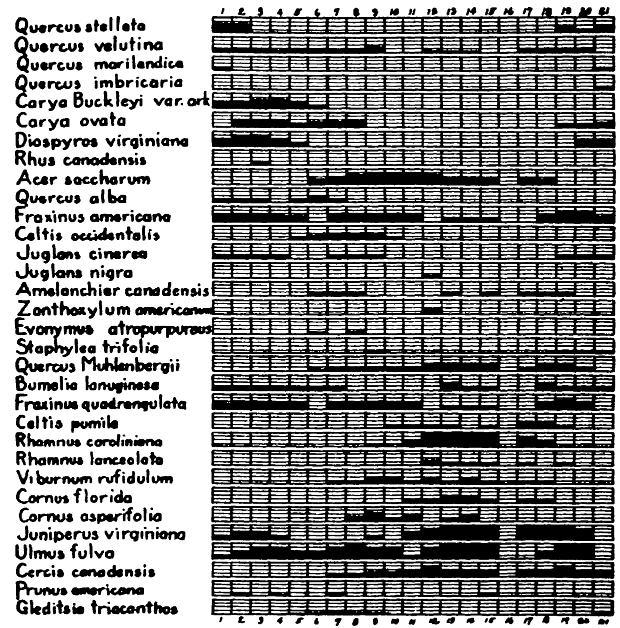

Fig. 14. Showing distribution and density of species in belt transect B.

Unit 1 = 0–1.4 plants; 2 = 1.5–2.4 plants; 3 = 2.5–4.4 plants; 4 = 4.5–7.4 plants; 5 = 7.5–11.4 plants; 6 = 11.5–16.4 plants; 7 = 16.5–22.4 plants; 8 = 22.5–29.4 plants.

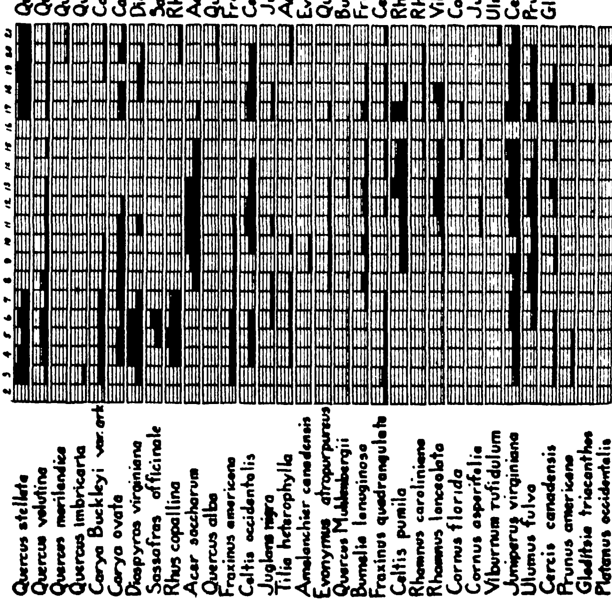

Fig. 15. Showing distribution and density of species in belt transect C.

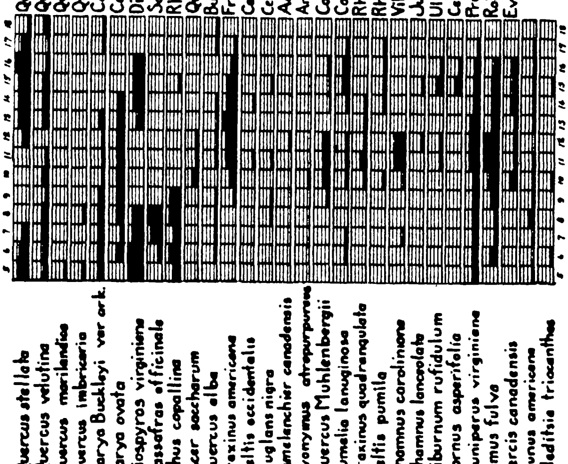

Fig. 16. Showing distribution and density of species in belt transect D.

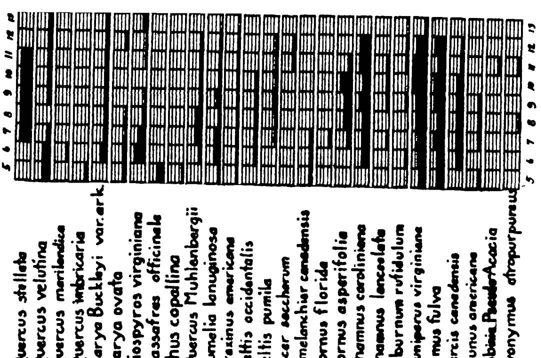

Fig. 17. Showing distribution and density of species in belt transect E.

slopes of Ledge Ridge. A third association is distinct in preferring the barren, rocky exposure of the west slope of Cliff Ridge. It is dominated by a growth of chinquapin oak and sugar maple. This association has a subordinate phase, a group of trees dominated by red cedar which prefers the more xerophytic environment of the glade.

The Oak-Hickory *(Quercus-Carya)* Association.—Grouped into this association are: post oak *(Quercus stellata)*, Ozark hickory *(Carya Buckleyi* var. *arkansana)*, black oak *(Quercus velutina)*, black jack oak *(Quercus marilandica)*, and the shingle oak *(Quercus imbricaria)* (figs. 13–17). The status of these trees within the association is not one of equal importance. A study of the belt-transect graphs indicates that the post oak and Ozark hickory are dominant. As stated above, these graphs are purely a study of density and distribution, and give no indications of size and age.

On Ledge Ridge and that portion of the ridge at the head of the valley, large trees are consistently white oak, black oak, and Ozark hickory. Judging from the ages of stumps of similar diameter elsewhere in the area their age varies between 150 and 200 years. This places them in that group comprising the relics of the virgin flora in which they may serve as indicators of the former climax.

On Cliff Ridge the conditions are not so easily read. The total deforestation of this portion (fig. 3c) has left no relic trees of the virgin forest. Although numerous stumps of trees, approximately 150–200 years old, are to be found, they were in a rather poor state of preservation and all that could be identified were oaks. The relatively great intervals at which the stumps occur seem to suggest that the trees were of stout, spreading habit such as that commonly developed by ridge-top post oaks. The probability of the former climax being composed essentially of post oak is supported by the fact that this ridge is for the most part very narrow. It receives little protection from hot dry winds by the surrounding ridges, and its high isolated position does not permit water to linger long either on or in the soil. Temperature recordings show that in summer this ridge is consistently warmer than the valley or lower habitats, and that during midday and early afternoon it is usually 5–8° warmer than a comparable station in the valley (fig. 8C). The present vegetation is predominantly of post oaks approximately 30 years old. Black oaks, white oaks, and Ozark hickories occur in minor numbers (figs. 13–17). Seedling trees are absent for the most part.

These facts seem to indicate the revival of a former post oak climax on this ridge. Although post oaks also occur in great numbers on Ledge Ridge (figs. 13–17), their distribution is different from that observed on Cliff Ridge. On Ledge Creek it is almost totally limited to the boundaries of the old deforested and pastured plot (figs. 3, 12), and exists as an associes, a stage leading to the development of the oak-hickory climax association.[13] The belt-transect graphs show a relatively high per cent of black oak, white oak, and Ozark hickory also composing this old pasture flora (figs. 13–16). These are, for the most part, young trees 5–10 years old, while the older post oaks are 21 years old, a fact which indicates that the oak-hickory climax common to Ozark ridges is rapidly becoming dominant.

An even earlier stage of the development in the succession from cleared ridge lands to an oak-hickory climax association is represented by the pioneer plants, now almost completely dominated by the post oak associes (fig. 12). Included in this "old field" associes are persimmon *(Diospyros virginiana)*, sassafras *(Sassafras officinale)*, and shinning sumac *(Rhus copallina)*. With the exception of the persimmon, which has a more general distribution, these occur as small "islands" only partially invaded by the more advanced stage of the post oak associes. A comparison of the composite map of the vegetation (fig. 12) with the map of the areal distribution of the various degrees of soil acidity (fig. 6) shows a very close correlation between the environment of these ridge-top trees and areas of high degree of soil acidity. The white and black oaks of this association have an indifferent attitude toward degree of soil acidity and appear quite generally over the entire area. The remaining members have distributional boundaries almost identical with the areas of acid soils. These correlations support Steyermark's conclusions concerning the vegetation of the Ozarks in Missouri.[14] No correlation could be found between this association and the soil types (fig. 5), nor could it be identified with any particular outcropping of the various rock strata (fig. 2) which at this point are deeply overlain with soil (fig. 4, a, b).

The White Oak–Sugar Maple *(Quercus alba–Acer saccharum)* Association.—The belt-transect graphs reveal a second prominent group of trees which conspicuously prefer the exposure of the east

[13] Steyermark, J. A. Studies of the vegetation of Missouri—I. Bot. Series, Field Mus. Nat. Hist. 9: 351–475. 1940.

[14] Ibid., p. 405.

slope of Ledge Ridge (fig. 12). Unlike the neighboring ridge, this association is represented by a large group of species: white oak *(Quercus alba)*, sugar maple *(Acer saccharum)*, white ash *(Fraxinus americana)*, black oak *(Quercus velutina)*, shagbark hickory *(Carya ovata)*, hackberry *(Celtis occidentalis)*, burning bush *(Evonymus atropurpurous)*, black walnut *(Juglans nigra)*, shadbush *(Amelanchier canadensis)*, and bladder-nut *(Staphylea trifolia)* (figs. 13–16). As indicated in the discussion of the preceding association, it is not possible to assign dominance to any several species solely on the basis of facts represented in the belt-transect graphs. This association is fortunate in having a considerable number of virgin trees. A comparison of their trunk diameters with those of stumps of readable age elsewhere in the area places all of these trees between 160 and 200 years old, in that age class which is conspicuously composed of virgin trees. They are all straight-boled and form a relatively high canopy broken where many of them died out when the environment was altered by grazing. Of the large and older trees, white oaks and sugar maples are dominant. Aged, living sugar maples are not common in the area, probably because they were unable to endure the conditions brought about by grazing, namely, the depletion of the thick layer of litter and humus on the forest floor. The association has a well-developed understory of bladder-nut *(Staphylea trifolia)*, spice bush *(Benzoin aestivale)*, prickly ash *(Zanthoxylum americanum)* and burning bush *(Evonymus atropurpureus)*. Seedlings and saplings of white oaks and sugar maples abound.

An attempt to correlate this association with the various environmental factors reveals that it corresponds most closely with the limits of alkaline soils of the lower portion of the east slope of Cliff Ridge (fig. 6). This association prefers a pH range from 6.8 to 8.5. Here the degree of acidity of the soil is affected to a greater extent by the underlying dolomitic limestone because the soil layer is considerably thinner, varying from 8 to 14 inches in depth. The association may be further correlated with the limits of the "rough stony land" on this slope (fig. 5). The eastern exposure of the slope on which this association has developed has caused it to assume a mesophytic aspect. Being exposed to the east as it is, the slope receives the direct rays of the sun only in the morning before the air has been heated up. Thus the sun has a less burning effect upon the foliage of the trees during the summer drought periods. The slope is shaded from the rays of the sun during the heat of the day, from

2 to 4 p. m. The temperatures recorded on the slope are consistently from 1 to 4° cooler than those of a comparable position on the western slope (fig. 9C). The greater equability of this environment as compared with the distinctly xeric habitat on the west slope is manifest in a more succulent herbaceous flora. Humus and litter have collected in a thicker carpet on the forest floor, thus protecting it from excessive erosion and likewise serving as a moisture-conserving mulch.

The Chinquapin Oak–Sugar Maple *(Quercus Muhlenbergii–Acer saccharum)* Association.—As previously stated, this association inhabits the western slope of Cliff Ridge (fig. 12). The dominant trees are chinquapin oak *(Quercus Muhlenbergii)* and sugar maple *(Acer saccharum)*. Other important members of the association are: red cedar *(Juniperus virginiana)*, chittim-wood *(Bumelia lanuginosa)*, black oak *(Quercus velutina)*, and blue ash *(Fraxinus quadrangulata)*. Trees playing a minor part in the association are white ash *(Fraxinus americana)* and black walnut *(Juglans nigra)*. Trees and shrubs forming the rich understory are: dwarf hackberry *(Celtis pumila)*, redbud *(Cercis canadensis)*, Indian cherry *(Rhamnus caroliniana)*, black haw *(Viburnum rufidulum)*, buckthorn *(Rhamnus lanceolata)*, flowering dogwood *(Cornus florida)* (figs. 13–16).

The association has a light, open aspect, no canopy in a true sense having been developed. Relatively few of the dominant trees are actually dead though many exist in a poor state of health. A comparison of the trunk diameters with stumps of known age places the majority of the older specimens in the group of virgin trees. The habit of these trees seems to suggest that the aspect of this association has not been appreciably altered by grazing conditions. The fact that these trees have a lower and more spreading branching habit than that of the typical forest specimens in the associations previously described indicates that they developed under conditions very similar to the semi-xerophytic ones existing today, and may perhaps account for the slight damage suffered from grazing.

It is probable that even prior to the advent of human activities in the area, the soil cover lay thin on the bed rock beneath, and that though a rather rich herbaceous flora had developed it was necessarily xerophytic in nature. These facts are in accord when one remembers that the western exposure of this habitat leaves it relatively unprotected from hot, dry south and southwestern summer

winds, and likewise raw, cold winter winds. The attitude of the slope causes it to have a high angle of incidence to the rays of the sun during the heat of the day, that is, from 2 p. m. to 4 p. m. This results in a temperature of 1–4° over that recorded at a comparable station on the east slope of Ledge Ridge (fig. 9). This xeric condition is intensified when the numerous thin-bedded phases and sand lenses incorporated in the rock strata are taken in consideration (fig. 1). These serve as drains through which percolating ground waters are rapidly conducted off, leaving little water in reserve for periods of drought despite the high organic content of the soil. As previously mentioned, the shallow depth of the soil has caused it to be exploited to a high degree by roots of trees and herbs, which necessarily means that it would be rapidly depleted of moisture regardless of the high content of organic matter. The relatively thin depth of the soil layer, together with its residual origin from the underlying dolomitic limestones, has favored the development of a typically alkaline soil (fig. 6) which is reflected markedly in the flora. Steyermark includes the dominant plants of this association in his list of plant indicators of alkaline soils.[15]

The Glade Associes.—The glade is a plant environment distinct from all other habitats presented by the area (fig. 1). The soil is very shallow, and numerous rock shelves are exposed, which, together with the conspicuous lack of trees over the greater part of its extent, give the glade a barren open aspect. Further inspection shows the position of the glade to be correlated with the extent of the outcropping of the upper, thin-bedded phase of the Cotter formation on this western slope. This suggests that the origin of the glade lies within the properties of this rock. In a previous paragraph this thin-bedded phase of the Cotter formation was characterized as being a highly porous and permeable rock. These features and the comparatively great depth, 7 feet, of this phase cause it to present a plant habitat with a wide range of seasonal conditions. The high porosity and permeability of the rock permit free movement of water. Early spring rains rapidly percolate through the rock or water may be drawn from it by rapid evaporation, having been brought to the surface by capillary action. This means that the rock creates an arid substratum during summer. In autumn and late winter another extreme is experienced. With the increase in precipitation and accompanying decrease in evaporative powers of

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[15] *loc. cit.*, p. 407.

the atmosphere, the rock becomes literally saturated with percolating ground water. The sparse plant cover does not bind the soil in place against spring and later summer rains (fig. 7). The surplus of water in the bedrock beneath the soil in winter forces its way to the surface of the rock, where, acting as a lubricant and erosive agent, it also carries the soil away. The western exposure of this unique environment only tends to intensify the already extreme edaphic conditions. In summer the hot, dry, southern and southwestern winds, and the high angle of incidence of this slope to the rays of the sun during the heat of the day, create intensely desiccating conditions.

The Open Glade Associes.—Almost the entire area of the glade is open (fig. 12), appearing like a barren, rocky, upland meadow. These conditions have resulted in almost total exclusion of an arborescent flora. Over the greater part of its extent an herbaceous associes prevails, Missouri black-eyed Susan–bluestem *(Rudbeckia missouriensis-Andropogon scoparius)*. Trees are excluded from the open glade, the arid summer conditions preventing the establishment of seedlings. However, several small "islands" of red cedars are trying to exist here.

The Closed Glade Associes.—The small closed glade is founded on essentially the same environmental conditions as those controlling the open glade. However, it differs from the open glade in being forested with a red cedar *(Juniperus virginiana)* associes. Other important trees are: chinquapin oak *(Quercus Muhlenbergii)* and chittim-wood *(Bumelia lanuginosa)*. A well-developed understory is composed of Indian cherry *(Rhamnus caroliniana)*, buckthorn *(Rhamnus lanceolata)*, dwarf hackberry *(Celtis pumila)*, black haw *(Viburnum rufidulum)*, redbud *(Cercis canadensis)*, and flowering dogwood *(Cornus florida)*. This associes is distributed as a narrow band bordering the upper edge of the open glade associes (figs. 1, 12), and may be correlated with the uppermost portion of the thin-bedded phase of the Cotter formation and the basal sandy phase of the Powell formation (figs. 2, 12). Here the substratum of rock remains more moist since it lies adjacent to the massive rocks of the Powell formation which retains percolating ground waters considerably longer than the thin-bedded cotton rock of the Cotter formation. Humus is washed down upon the glade from the oak woods above it and is an important factor in increasing the soil moisture since it serves as both a reservoir of

moisture and as a mulch. This increase in soil moisture has permitted the invasion of trees upon the glade edge. The extremely xeric conditions prevailing during the summer months, however, limits the habitat to occupation by drought-resistant species such as red cedar, chittim-wood, and chinquapin oak. Though a canopy of interlacing cedar boughs is well developed it is characteristically of a gauze-like texture, and permits abundant light to encourage the rich understory of small trees and shrubs.

These glade associes have, in all probability, been the least injured by grazing. The xerophytic nature of the open glade necessarily produces plants of a tough, leathery texture which offers little encouragement to cropping by animals. A thick mat of slowly decaying cedar needles prevents seeds of herbs from reaching a suitable stratum for germination. Thus it is evident that this associes was undisturbed by livestock. A portion of the associes was deforested (fig. 3c), but this caused little alteration of the flora aside from the removal of the virgin trees. Steyermark has shown how similar glades and rocky barrens in the Ozarks are invaded and dominated in part by red cedar and chittim-wood among other trees.[16] Dead or dying specimens are almost totally absent. It is evident that this associes exists today much as it must have before settlement of the region by white man.

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[16] *loc. cit.*, p. 372–377.

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HELMINTHOSPORIUM SPOT OF CITRONELLA AND LEMON GRASS IN GUATEMALA

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During August, 1941, a severe epiphytotic developed on citronella (*Cymbopogon Nardus* (L.) Rendle subspec. *genuinus*) and lemon grass (*Cymbopogon citratus* (DC.) Stapf) at Los Cerritos, a very large plantation near the upper edge of the coastal plain below Escuintla in Guatemala. The weather had been somewhat abnormal, with earlier light rains and higher humidities at the end of the preceding dry season, although the rainfall for the whole subsequent rainy season was not conspicuously high. Owing to the increased demand for essential oils, the plantation had been irrigated throughout the dry season instead of cutting off the water for the last two or three months as in previous years. This kept the trash and marcescent leaves at the bases of the plants moist for the production of a larger number of spores while the higher humidities probably aided in securing more abundant germination and infection. By the end of August all but the very young leaves had died back about half their length, and the distilling plant was closed for about six weeks for the first time since the plantation came into production about ten years before.

An examination of a large number of plants showed that the principal damage resulted from a leaf spot, although an occasional plant of citronella showed a rot associated with *Fusarium* sp. at the bases of the stems a short distance above the soil. The leaf spot begins as a small yellowish area between the veins. It develops more rapidly between the veins than across the smaller ones, resulting in an elliptic to nearly linear area of necrosis with a reddish margin, quite similar in appearance to the *Helminthosporium* leaf spot of sugar cane. The central portion soon becomes brown and dry, but does not drop out. As the spots increase in number, evidently the water supply is reduced and the distal portion of the leaf slowly

[1] On leave of absence, 1941-42.

Issued April 20, 1942

wilts and dies. Transverse sections of the leaf through a leaf spot apparently show cross-sections of thick-walled, brownish hyphae in the phloem of the bundle next the leaf spot, with the whole phloem area brown and necrotic. The dead tissue may then be invaded by saprophytes such as *Hormodendrum.*

The *Helminthosporium* was easily isolated on Thaxter's potato-glucose agar and grows equally well on Sabouraud's glucose agar, although on both media the spores are somewhat smaller (24–35 × 8–15.5 μ, average 29.5 × 12.4 μ) than when developed on the host (46–54 × 18–24 μ, average 49 × 20 μ). The strain on lemon grass has somewhat smaller spores (19.5–28.6 × 7–15 μ, average 25.8 × 10 μ) than those of the citronella strain, but further study will be necessary to determine whether the difference is significant as no morphological differences have been noticed.

On the host, the conidia develop at the tip of a short, stiff conidiophore. As the first spore develops, the supporting cell proliferates dichotomously and produces a second spore. This may be repeated, giving about three spores in a compact group at the tip of the conidiophore as in *Acrothecium* (pl. 13, fig. 8). The mature spore is asymmetric, flattened on one side or somewhat curved, with one cell (usually the subterminal) much larger than the others.

In agar colonies, conidia are borne singly, both terminally and laterally (pl. 13, figs. 5, 10, 11), as well as in a terminal group on short lateral branches corresponding to the conidiophores on the host (pl. 13, figs. 6, 11). In the original cultures on potato-glucose agar, the large subterminal cell of the conidium often proliferated laterally, producing a mature spore suggestive of the staurospore found in *Triposporium* Corda (pl. 13, figs. 4, 6, 11). This type of spore has not been seen in subcultures on Sabouraud's glucose agar, prepared from the original cultures after six months.

The systematic position of this organism is not altogether clear from the limited literature at my disposal. The staurospores are considered as abnormal since I have found them only in cultures on potato-glucose agar, and may result from some morphogenetic stimulus in the medium. The grouping of spores at the tip of the conidiophore suggests *Acrothecium* Preuss but is believed to result from a different ontogeny, similar to that of *Helminthosporium Sacchari* (Breda da Haan) Butler, if the internodes between spores were greatly shortened and the spores were less caducous. *Brachysporium* Saccardo and *Napicladium* Thuemen resemble our organism in many respects, but their distinction from *Helmintho-*

sporium Link is not clear. Hence in the absence of further information regarding this group of genera, I have preferred to describe the species in the oldest genus.

HELMINTHOSPORIUM **Cymbopogi** Dodge, sp. nov.

Conidiophori rigidi, erecti, fumosi vel obscure brunnei, septati neque ad septa constricti neque ramificati; conidia 3–5-septata, terminalia, singula vel in capitulis parvis, asymmetrica, uno latere applanata aut leviter curvata, 46–54 × 18–24 μ.

Conidiophores rigid, erect, smoky or dark brown, septate, not constricted at the septa nor branched; conidia with 3–5 thick, transverse septa, terminal, single or in small groups, asymmetric, flattened on one side or slightly curved, thick-walled, usually with the penultimate cell much larger than the others, 46–54 × 18–24 μ.

Guatemala: Escuintla, Los Cerritos, *Dodge,* on citronella, TYPE; same locality and collector, on lemon grass.

The spore germinates from the basal cell by a tube which pushes between the epidermal cells until it is below the thicker portion of the wall of the host cell, then penetrates the epidermal cell (pl. 13, fig. 7). If the tube fails to penetrate, it forms a dichotomously branched mycelium (pl. 13, figs. 1, 9).

Preliminary experiments indicate that this disease may be controlled by spraying with either Bordeaux mixture or lime-sulfur. A promising beginning has been made in the selection of resistant clones. Two clones with a relatively small amount of infection in a very heavily infected area were selected, divided into the usual seed bits and planted in a freshly prepared section of the plantation. As they mature for the first cutting, about half of them are relatively free from infection. The other half and the surrounding area are again heavily infected, as this area has not yet been sprayed owing to lack of adequate equipment for spraying such a large plantation. It is hoped to carry this selection further, since in normal times the cost of spraying is so great that it will be impossible for Guatemalan farmers to compete with those in other regions with much lower labor costs.

EXPLANATION OF PLATE

PLATE 13

Fig. 1. Germinating spore of *Helminthosporium Cymbopogi* Dodge, strain on citronella.

Fig. 2. Terminal group of conidia, strain on lemon grass, from cultures.

Fig. 3. Younger stage of the above. The older spore on the right has already thickened its walls, while the younger one on the left has just produced transverse septa.

Fig. 4. Conidia of the strain on lemon grass from potato-glucose agar culture.

Fig. 5. Single terminal conidium of the strain on lemon grass from potato-glucose agar culture.

Fig. 6. Group of conidia, strain on lemon grass from potato-glucose agar culture. This hypha is more moniliform than the usual hyphae in cultures.

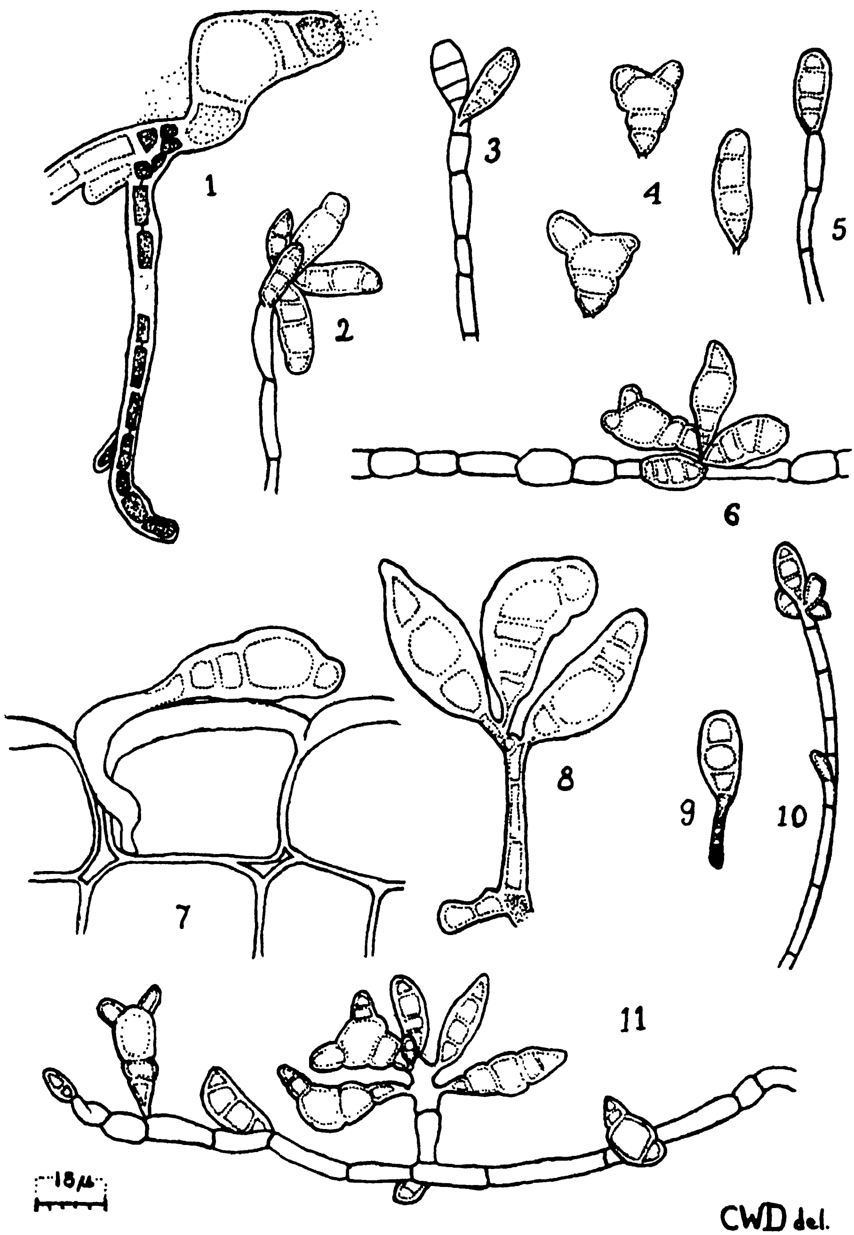
Fig. 7. Germinating conidium, showing method of penetration of the citronella leaf epidermis.

Fig. 8. Conidiophore and group of conidia on leaf of citronella.

Fig. 9. Germinating conidium of lemon grass strain from culture.

Fig. 10. Very young terminal group of conidia of lemon grass strain; only the first spore has thickened its walls, the second spore has divided only once, while the two youngest spores have not begun to divide. A young spore is forming laterally below.

Fig. 11. Various types and groupings of conidia of the citronella strain from potato-glucose agar culture along a single hypha.



DODGE—HELMINTHOSPORIUM CYMBOPOGI

Annals
of the
Missouri Botanical Garden

Vol. 29 SEPTEMBER, 1942 No. 3

COMMENTARY ON THE NORTH AMERICAN GENERA OF COMMELINACEAE

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During the course of a revision of the species of *Tradescantia* indigenous to the United States, published several years ago,[1] I found it advisable to make some correlative observations upon the genus as a whole and the American representation of the family generally. These rather casual excursions afield were both comforting and disquieting, for they showed that, although the Tradescantias of the United States are relatively homogeneous phylogenetically, those of the tropics are extremely heterogeneous, and also that the systematics of the family, at least in North America, is very precarious indeed. Such being the case, I fixed my attention upon the limited job in hand with a profound sense of thanks to Providence for my lot at that time, and a nebulous vow of propitiation by a revision of the tropical Spiderworts in the indefinite future. The "future" has arrived rather unexpectedly at last, for I find my vow exacted by the needs of the 'Flora of Panama' upon which I have been working for some years past.

The Commelinaceae always have been difficult subjects for herbarium study because of their deliquescent flowers. It is not easy to understand, therefore, why previous systematists of the family have focused almost their whole attention upon floral structure in the delimitation of subfamilies, tribes, and genera. In his account of the family for de Candolle's 'Monographiae', C. B. Clarke[2]

[1] Anderson, E., and R. E. Woodson, Jr. Contr. Arnold Arb. 9: 1–132. 1935.
[2] C. B. Clarke, in A. & C. DC. Monogr. 3: 115–324. 1881.

erected three tribes, Pollieae, with fruit indehiscent, Commelineae, with dehiscent fruit, fertile stamens 3–2, sterile stamens 0–4, and Tradescantieae, with dehiscent fruit, fertile stamens 6–5. In establishing these groups, Clarke found it prudent, in the case of the last two tribes, to call attention to exceptions amongst a number of genera obviously included arbitrarily within either tribe in spite of divergence from the characters of diagnosis. The modern reader probably will find it difficult to understand why *Phaeosphaerion (Athyrocarpus)* was placed within the Pollieae, whilst *Commelina* remained with several discrepant genera in the Commelineae, as well as why *Callisia* was placed within the Tradescantieae, upon the characters provided, since the greater number of its species (as interpreted by Clarke himself) have only 1 to 3 stamens. Numerous other instances of ambiguity and inconsistency could be mentioned.

The most recent general system of Commelinaceae is that by Brückner[3] for Engler's 'Natürlichen Pflanzenfamilien', in which two subfamilies are provided: Tradescantieae, with actinomorphic flowers, and Commelineae, with flowers zygomorphic. With such distinctive terms employed in the general key, the reader is prone to remember the regular flowers of *Tradescantia* and the strongly irregular flowers of *Commelina* (as he is apt to be acquainted with them), and to proceed on his way until tripped by the deliquescent flowers from the herbarium before him or stopped dead in his tracks by a reference to the text of the generic descriptions of Commelineae. These usually side-step the issue of zygomorphy entirely or admit inconsistency (as for *Aneilema*, p.175: "Pet. frei, das äussere *mitunter* kleiner" [italics mine]). Reference to herbarium specimens and to standard icones shows that in most genera the zygomorphy of the corolla is either absent or so slight that it is highly impractical. Brückner further divides the Tradescantieae into two tribes, Hexandrae and Triandrae, upon the basis of "6 fertile Stam." and "3 fertile Stam., 3 oder O sterile", respectively. The latter, of course, is highly embarrassing to such a genus as *Callisia*, the fertile stamens of which vary from 1 to 6, without accompanying staminodes.

Generic characters used by both Clarke and Brückner, as well as by less prominent authors, have tended to accentuate the stamen constituency, as number of fertile stamens, presence of staminodia, bearding, etc. My general impression, based upon observations of

[3] Brückn. in Engl. & Prantl, Nat. Pflanzenfam. **15a**: 159–181. 1930.

such genera as *Callisia* and *Tripogandra (Descantaria)*, is that the stamens of the family show great variation frequently amongst species of a single genus. An outstanding example of the impracticality of Brückner's application of staminal characters is provided by his inclusion of *Descantaria* within the Hexandrae and *Neodonnellia* within the Triandrae. Even a casual examination of representative species shows that the outer stamens of both are essentially alike.

In making a major subdivision of the Commelinaceae, I would base my separation upon inflorescence structure. In the entire family the basic inflorescence design is the scorpioid cyme. But in the Commelineae, as I distinguish the tribe, the ultimate branches or units of the inflorescence are composed of individual scorpioid cymes which appear 1-sided superficially; these may be solitary or variously compounded even in a given species, or very rarely reduced to a solitary flower. In my interpretation of the Tradescantieae, on the other hand, the basic structure of the inflorescence has been modified so that the ultimate branches or units of the inflorescence are *paired sessile* scorpioid cymes which appear as a 2-sided unit superficially, rarely reduced to a solitary flower.

Very little experience is necessary both to distinguish these types of inflorescence and to appreciate their validity. At first, the observer may confuse occurrences of separate but superficially paired inflorescences of the Commelineae type with the more highly evolved type characteristic of the Tradescentieae. But closer examination of such specimens (as in *Tinantia leiocalyx* Clarke) will show that pairing here is merely a numerical chance and not a concrete unit of structure as in the whole tribe Tradescantieae. The paired cymes of *Tradescantia* and its near relatives, also, are likely to cause trouble at first, because they are so condensed. But superficially they usually will appear 2-sided or "parted in the middle", which a dissection or closer examination will confirm.

The paired cymes of the Tradescantieae are considered to be an integral condensation derived from the individual cymes of the Commelineae. Amongst the genera of this tribe condensation proceeds within the limits of the paired cyme. In the genus *Tripogandra* the paired cymes are borne at the tip of a common naked peduncle which usually is elongate, although greatly foreshortened in *T. Warscewicziana*, a species somewhat transitional to *Callisia*. These pedunculate cymes may be terminal or axillary to a stem

aa. Ultimate branches of the inflorescence composed of paired sessile scorpioid cymes appearing as a 2-sided unit superficially, rarely reduced to a solitary flower; corolla regular *(Tradescantieae)*.
  b. Corolla apopetalous, the petals free to the base.
    c. Paired cymes distinctly pedunculate, never sessile and subtended by leafy bracts (but the bracteoles rarely somewhat foliaceous in part); stamens 6, usually in 2 very dissimilar series, the outer occasionally sterile, rarely all fertile and essentially similar; sepals foliaceous or petalaceous.. VIII. TRIPOGANDRA
    cc. Paired cymes sessile and subtended by more or less conspicuous leafy bracts, rarely appearing pedunculate and the bracts greatly reduced, but the stamens usually 1–3, rarely 6, all fertile, and the sepals paleaceous....IX. CALLISIA
    ccc. Paired cymes sessile and subtended by conspicuous bracts essentially similar to the leaves (coriaceous spathes in *Rhoeo)*; stamens 6, all fertile and essentially similar; sepals foliaceous or petalaceous.
      d. Cymes on slender peduncles lateral to the main stem.
        e. Flowering peduncles elongate, usually branched; bracts foliaceous; sepals becoming fleshy in fruit............................X. CAMPELIA
        ee. Flowering peduncles very short, simple; bracts appearing as coriaceous spathes; sepals drying in fruit..........................XI. RHOEO
      dd. Cymes terminal to the main stem, occasionally also lateral in the upper leaf axils; lateral cymes very rarely reduced to a solitary flower...XII. TRADESCANTIA
  bb. Corolla gamopetalous, the petals united at the base.
    c. Flowers borne in leafy-bracted cymes; corolla tube relatively short; plants with extensive creeping stems.
      d. Sepals separate, foliaceous; plants tumid...............XIII. SETCREASEA
      dd. Sepals united into an unequally-lobed tube, hyaline; plants somewhat succulent, but not tumid..................................XIV. ZEBRINA
    cc. Flowers solitary and sessile in the axils of the congested upper leaves; corolla tube long and slender; semiacaulescent alpines........XV. WELDENIA

I. DICHORISANDRA Mikan, Del. Fl. & Faun. Bras. *pl. 3.* 1820; C. B. Clarke in A. & C. DC. Monogr. **3**: 272. 1881; Brückn. in Engl. & Prantl, Nat. Pflanzenfam. **15a**: 170. 1930, nom. conserv.

? *Stickmannia* Neck. Elem. **3**: 171. 1791, nom. rejic.

Petaloxis Raf. Fl. Tellur. 2: 83. 1836 [1837].

This is one of the most distinctive genera of Commelinaceae, as is shown particularly by the anthers and arillate fruit. The petals, also, are much more resistant to deliquescence than those of other Spiderworts. The genus is best represented in Brazil, from whence nearly 30 species have been described, mostly spurious, I suspect upon the basis of familiarity with the common and highly variable *D. hexandra* (Aubl.) Standl. in Panama.

II. ANEILEMA R. Br. Prodr. 270. 1810; C. B. Clarke, loc. cit. 195. 1881; Brückn. loc. cit. 174. 1930.

Murdannia Royle, Illustr. Bot. Himal. 403. *pl. 95.* 1839 [1840]. Brückn. loc. cit. 173. 1930; also numerous other Asiatic and African synonyms for both genera enumerated by Clarke and Brückner.

I am placing within *Aneilema* the erstwhile species of *Tradescantia* having simple scorpioid cymes as component units. This is an entirely natural procedure as anyone who examines a suite of the large Asiatic and African genus will see. Why these plants were ever placed within *Tradescantia* in the first place is hard to understand. The Old World species of *Aneilema* present much variation in inflorescence modification, and it is significant to find that those of America follow much the same system of variation. Although *Aneilema (sensu stricto)* was placed in the Commelineae and *Murdannia* in the Tradescantieae by Brückner, it seems quite obvious to me that the two are congeneric. The irregularity of the corolla of the former, as Brückner himself confesses, is only occasional ("Pet. frei, das äussere mitunter kleiner", p.175) ; while the same, oddly enough, can be said for the regularity in *Murdannia* ("Pet. frei, mitunter das äussere wenig anders gestaltet", p.173).

ANEILEMA **chihuahuensis** (Standl.) Woodson, comb. nov.
Tradescantia chihuahuensis Standl. Field Mus. Publ. Bot. **17**: 227. 1937.

ANEILEMA **geniculata** (Jacq.) Woodson, comb. nov.
Tradescantia geniculata Jacq. Select. Stirp. Amer. 94. *pl. 64.* 1763; C. B. Clarke, loc. cit. 300. 1881.

ANEILEMA **Greenmanii** Woodson, nom. nov.
Tradescantia macrophylla Greenm. Proc. Amer. Acad. **33**: 472. 1898, non *Aneilema macrophylla* R. Br.

ANEILEMA **holosericea** (Kunth) Woodson, comb. nov.
Dichorisandra longifolia Mart. & Gal. Bull. Acad. Brux. **9**^{2}: 378. 1842, non *Aneilema longifolia* Wall. nec Hook.
Tradescantia floribunda Mart. & Gal. loc. cit. 377. 1842, non *Aneilema floribunda* Hook. & Arn.
Tradescantia holosericea Kunth, Enum. **4**: 92. 1843; C. B. Clarke, loc. cit. 302. 1881.
Tradescantia holosericea Kunth β. *dracaenoides* C. B. Clarke, loc. cit. 1881.
Tradescantia longifolia (Mart. & Gal.) Greenm. Proc. Amer. Acad. **33**: 471. 1898.

Tradescantia dracaenoides (Clarke) Greenm. Proc. Amer. Acad. **39**: 70. 1903.

Certain of the several varieties of this species, as enumerated by Clarke, may well be entitled to specific rank, others appear questionable even as varieties. This is a question that must await monographic study.

ANEILEMA **Karwinskyana** (R. & S.) Woodson, comb. nov.

Tradescantia Karwinskyana R. & S. Syst. **7**: 1165. 1830; C. B. Clarke, loc. cit. 299. 1881.

ANEILEMA **linearis** (Benth.) Woodson, comb. nov.

Tradescantia linearis Benth. Pl. Hartweg. 27. 1839; C. B. Clarke, loc. cit. 298. 1881.

Tradescantia graminifolia Mart. & Gal. loc. cit. 378. 1842.

Tradescantia venustula Kunth, Enum. **4**: 87. 1843; C. B. Clarke, loc. cit. 298. 1881.

Tradescantia rhodantha Torr. Bot. Mex. Bound. Surv. 225. 1859.

Tradescantia linearis Benth. β. *graminifolia* (Mart. & Gal.) C. B. Clarke, loc. cit. 299. 1881.

ANEILEMA **pulchella** (HBK.) Woodson, comb. nov.

Tradescantia pulchella HBK. Nov. Gen. & Sp. **1**: 262. 1815 [1816]; **7**: *pl. 673.* 1825; C. B. Clarke, loc. cit. 297. 1881.

III. TINANTIA Scheidw. in Otto & Dietr. Allgem. Gartenzeit. **7**: 364. 1839; C. B. Clarke, loc. cit. 285. 1881; Brückn. loc. cit. 175. 1930, nom. conserv.

Pogomesia Raf. loc. cit. 67. 1836 [1837]. nom. rejic.

I have criticized Brückner in his use of regularity or irregularity of the corolla so severely in preceding paragraphs, that I find it necessary to apologize for my use of the same character in distinguishing *Aneilema* and *Tinantia*. As I have explained (p. 147), however, the irregularity of the corolla of *Aneilema* and the irregularity of *Murdannia* as applied by Brückner is merley a variable comparison of size of the petals. The flowers of *Tinantia,* on the other hand, are as incontestably irregular as are those of *Commelina,* not only in size of the petals, but in their coloration and structure of the stamens. The species of *Tinantia* are extremely variable in the size of the plants and the degree of compounding of their inflorescences.

IV. FLOSCOPA Lour. Fl. Cochinch. 192. 1790; C. B. Clarke, loc. cit. 265. 1881; Brückn. loc. cit. 176. 1930.

Dithyrocarpus Kunth, loc. cit. 76. 1843.

I regard *Floscopa* as very closely related to *Tinantia,* with which I would unite it were it not for the 2-celled ovary and capsules. The common species of Central America, *F. robusta* (Seub.) Clarke, sets seeds with the most astonishing abundance and rapidity.

V. COCHLIOSTEMA Lem. Illustr. Hort. **6**: Misc. 70. *pl. 217.* 1859; C. B. Clarke, loc. cit. 231. 1881; Brückn. loc. cit. 180. 1930.

This magnificent monotypic genus has recently been discovered in Panama. The thick indument of the petal margins is remarkable, as it is composed of beaded hairs similar to those of the staminal filaments of the family generally.

VI. COMMELINA L. Sp. Pl. 60. 1753; C. B. Clarke, loc. cit. 138. 1881; Brückn. loc. cit. 177. 1930, also numerous synonyms supplied by Clarke and Brückn.

Sauvallea Wright in Sauv. Fl. Cub. 156. 1873.

Commelinantia Tharp, Bull. Torrey Club **49**: 269. 1922.

The genus *Commelina* is represented by more species in the Old than in the New World. Amongst the Old World species are found many startling morphological departures, as judged from the species of the United States, including forms with 2- or 3-loculed ovaries, others with variable numbers of flowers or even stamens, wide variations in bearding of stamens, and in relative size of the petals. Such being the case, it seems in every way better to combine *Sauvallea* and *Commelinantia* within the inclusive genus.

COMMELINA **anomala** (Torr.) Woodson, comb. nov.

Tradescantia anomala Torr. Bot. Mex. Bound, Surv. 225. 1859.

Tinantia anomala (Torr.) C. B. Clarke, loc. cit. 287. 1881.

Commelinantia anomala (Torr.) Tharp, Bull. Torrey Club **49**: 269. 1922; Brückn. loc. cit. 176. 1930.

The interested reader should refer to Dr. Tharp's full account of the reasons for regarding this species as a distinct genus. I do not think it necessary to answer his arguments in detail, for that would entail an extended discussion of morphology with particular regard to the Asiatic species of *Commelina* beyond immediately profitable ends. The student of Commelinaceae who reads this inadequate paragraph, however, may be sufficiently familiar already with the

variable species of the Old World and with the perplexing variability of the whole family, for that matter, and probably will well understand the taxonomic confusion in the family that would be caused by over-evaluation of such characters as bearding of the stamens, etc., etc.

In the Gray Herbarium Card Index there is already an entry for "*Commelina anomala* Torrey" ex Tharp, loc. cit., so a word of explanation for the new combination here is necessary. The source of the Card Index entry is a footnote to Dr. Tharp's paper on *Commelinantia* (Bull. Torrey Club **49**: 269. 1922), which explains that Dr. Torrey first determined the type specimen as "*Commelyna anomala* Torr.", later striking out the "*Commelyna*" and substituting "*Tradescantia*". It seems quite clear that this publication in Dr. Tharp's footnote cannot be maintained as valid, as it violates Article 40 of the International Rules, being patently citation as a synonym.

COMMELINA **Blainii** (Wright) Woodson, comb. nov.

Sauvallea Blainii Wright, loc. cit. 157. 1873; C. B. Clarke, loc. cit. 315. 1881; Brückn. loc. cit. 171. 1930.

The distinctive characters of *Sauvallea* are the 6 fertile stamens and the solitary flowers, which, however, are enclosed within the characteristic spathe of the familiar Commelinas. The petals are subequal. These variants from the general run of Commelinas, however, are of the sort not found to be good generic criteria in the Commelinaceae, and even Clarke called attention to the similarity to *Commelina*.

VII. PHAEOSPHAERION Hassk. Flora **49**: 212. 1866; C. B. Clarke, loc. cit. 135. 1881.

Athyrocarpus Schlecht. Linnaea **26**: 454. 1853; Brückn. loc. cit. 179. 1930.

Phaeosphaerion is recognized here since there can be no doubt that *Athyrocarpus* was merely a suggested segregation from *Commelina* as far as Schlechtendal was concerned, and no formal transfer was made under *Athyrocarpus*.

VIII. TRIPOGANDRA Raf. Fl. Tellur. **2**: 16. 1836 [1837], emend.

Heminema Raf. loc. cit. 17. 1837.

Descantaria Schlecht. Linnaea **26**: 140. 1853; Brückn. loc. cit. 171. 1930, nom. subnud. provis.

Disgrega Hassk. Flora **49**: 215. 1866, nom subnud.
Leptorhoeo C. B. Clarke in Hemsl. Diagn. Pl. Nov. 55. 1880; C. B. Clarke, loc. cit. 317. 1881; Brückn. loc. cit. 167. 1930.
Cuthbertia Small, Fl. Southeast. U. S. 237. 1903.
Donnellia C. B. Clarke, Bot. Gaz. **33**: 261. 1902.
Neodonnellia Rose, Proc. Biol. Soc. Wash. **19**: 96. 1906; Brückn. loc. cit. 174. 1930.

Tripogandra, Heminema, Descantaria, Disgrega, Donnellia, and *Neodonnellia* all were erected to include species, previously placed in *Tradescantia,* having two greatly dissimilar stamen series, the outer with shorter filaments and anthers (occasionally sterile) quite different from those of the inner. Species of *Leptorhoeo* and *Cuthbertia* have essentially similar stamens, but without the foliaceous bracts of *Tradescantia (sensu stricto).* In addition, the former is supposed to be distinguished by having the seeds solitary in the locules of the capsules.

Tripogandra is emended here to include these numerous elements for the following reasons: (1) It is obvious to any student of the *Tradescantia* complex that there is a marked tendency towards inequality of the stamens throughout; even in the *Descantaria* group such characters as the bearding of the stamens are quite variable, and could be made the basis of further dubious generic segregations, which are devoutly to be avoided; (2) seed number in the locules of the capsules varies amongst individual plants of a single species (cf. Anderson & Woodson, Contr. Arnold Arb. **9**: 27–29. *pl. 7.* 1935). In my revision with Anderson, to which reference has been made, *Cuthbertia* was included with *Tradescantia,* for it was not at that time realized that the bracts of the latter were wholly lacking in the former. It is now recognized that such is the case (cf. p. 143, paragraph 3, of this paper), and that the foliaceous structures at first interpreted as bracts are in reality the lower bracteoles of the paired cymes, as is shown by their orientation.

I do not understand why *Descantaria* was taken up by Brückner, as Schlechtendal published it merely as a suggested segregation from *Tradescantia,* without a description, as a matter of fact without even indicating valid reasons for separating it, and without making any formal transfers of species. *Tripogandra* and *Heminema,* on the other hand, are quite well described as Rafinesquian genera go, and there can be no doubt of their application. Characteristically, both genera consist of the same species, *Tradescantia*

multiflora, although Rafinesque credits one to Schwarz and the other to Jacquin.

TRIPOGANDRA **amplexicaulis** (Kl.) Woodson, comb. nov.
Tradescantia amplexicaulis Kl. ex C. B. Clarke, loc. cit. 304. 1881.
Descantaria amplexicaulis (Kl.) Brückn. loc. cit. 1927; loc. cit. 1930.

TRIPOGANDRA **angustifolia** (Rob.) Woodson, comb. nov.
Tradescantia angustifolia Rob. Proc. Amer. Acad. **27**: 185. 1892.
Descantaria angustifolia (Rob.) Brückn. Notizblatt **10**: 56. 1927; Brückn. in Engl. & Prantl, loc. cit. 171. 1930.

TRIPOGANDRA **cumanensis** (Kunth) Woodson, comb. nov.
Tradescantia cumanensis Kunth, Enum. **4**: 96. 1843; C. B. Clarke, loc. cit. 306. 1881.
Descantaria cumanensis (Kunth) Schlecht. ex Brückn. loc. cit. 1927; loc. cit. 1930.

TRIPOGANDRA **Disgrega** (Kunth) Woodson, comb. nov.
Tradescantia Disgrega Kunth, loc. cit. 97. 1843; C. B. Clarke, loc. cit. 305. 1881.
Disgrega mexicana Hassk. ex C. B. Clarke, loc. cit. 1881, nom. nud. in synon.
Descantaria Disgrega (Kl.) Brückn. loc. cit. 1927; loc. cit. 1930.

TRIPOGANDRA **elongata** (G. F. W. Meyer) Woodson, comb. nov.
Tradescantia elongata G. F. W. Meyer, Fl. Esseq. 146. 1818; C. B. Clarke, loc. cit. 303. 1881.
Descantaria elongata (G. F. W. Meyer) Brückn. loc. cit. 1927; loc. cit. 1930.

TRIPOGANDRA **floribunda** (Hook. & Arn.) Woodson, comb. nov.
Aneilema floribunda Hook. & Arn. Bot. Beechey Voy. 311. 1840.
Tradescantia filiformis Mart. & Gal. Bull. Acad. Brux. **9**^{2}: 276. 1842.
Leptorhoeo filiformis (Mart. & Gal.) C. B. Clarke in Hemsl. Diagn. Pl. Nov. 55. 1880; C. B. Clarke, loc. cit. 317. 1881; Brückn. loc. cit. 167. 1930.
Leptorhoeo floribunda (Hook. & Arn.) Baill. Hist. Pl. **13**: 218. 1894.

Three errors are widespread in citing this species under *Leptorhoeo,* including two variants in spelling the generic name *(Leptorrhoeo, Leptorhoës),* and the combination itself is frequently accredited to Hemsley (even the citation of Clarke himself in DC. Monogr.).

TRIPOGANDRA **grandiflora** (Donn. Sm.) Woodson, comb. nov.
Callisia grandiflora Donn. Sm. Bot. Gaz. **31**: 125. 1901.
Donnellia grandiflora (Donn. Sm.) Clarke, Bot. Gaz. **33**: 261. 1902.
Neodonnellia grandiflora (Donn. Sm.) Rose, Proc. Biol. Soc. Wash. **19**: 96. 1906; Brückn. loc. cit. 174. 1930.

TRIPOGANDRA **Lundellii** (Standl.) Woodson, comb. nov.
Tradescantia Lundellii Standl. Field Mus. Publ. Bot. **22**: 5. 1940.

TRIPOGANDRA **minuta** (C. B. Clarke) Woodson, comb. nov.
Tradescantia minuta C. B. Clarke, loc. cit. 307. 1881.
Descantaria minuta (C. B. Clarke) Brückn. loc. cit. 56: 1927; Brückn. in Engl. & Prantl, loc. cit. 171. 1930.

TRIPOGANDRA MULTIFLORA (Sw.) Raf. loc. cit. 16. 1836 [1837].
Tradescantia multiflora Sw. Prodr. 57. 1789; C. B. Clarke, loc. cit. 305. 1881.
Tradescantia procumbens Willd. Sp. Pl. **2**[1]: 19. 1800.
Heminema multiflora (Sw.) Raf. loc. cit. 17. 1836 [1837].
Descantaria procumbens (Willd.) Hassk. ex C. B. Clarke, loc. cit. 1881, nom. nud. in synon.
Descantaria multiflora (Sw.) Brückn. loc. cit. 56. 1927; Brückn. in Engl. & Prantl, loc. cit. 172. 1930.

TRIPOGANDRA **Palmeri** (Rose) Woodson, comb. nov.
Tradescantia Palmeri Rose, Contr. U. S. Nat. Herb. **1**: 113. 1891.
Descantaria Palmeri (Rose) Brückn. loc. cit. 56. 1927.

TRIPOGANDRA **rosea** (Vent.) Woodson, comb. nov.
Tradescantia rosea Vent. Jard. Cels. *pl. 24.* 1800; Anders. & Woods. loc. cit. 112. 1935; C. B. Clarke, loc. cit. 298. 1881; Brückn. loc. cit. 167. 1930.
Cuthbertia rosea (Vent.) Small. Fl. Southeast. U. S. 237. 1903.

I am not making adjustments under *Tripogandra* for the two varieties which Anderson and I recognized under *T. rosea* in our

earlier revision (loc. cit. 1935), as I am not certain whether they should be interpreted as varieties or species. This is a question that can be settled only by extensive field study.

TRIPOGANDRA **saxicola** (Greenm.) Woodson, comb. nov.

Tradescantia saxicola Greenm. Proc. Amer. Acad. **39**: 70. 1903.

Descantaria saxicola (Greenm.) Brückn. loc. cit. 56. 1927.

TRIPOGANDRA **Warscewicziana** (Kunth & Bouché) Woodson, comb. nov.

Tradescantia Warscewicziana Kunth & Bouché, Ind. Sem. Hort. Berol. **11**: 1847; C. B. Clarke, loc. cit. 302. 1881.

Spironema Warscewiczianum Hassk. ex. C. B. Clarke, loc. cit. 1881, nom. nud. in synon.

Spironema Warscewiczianum (Kunth & Bouché) Brückn. loc. cit. 171. 1930.

IX. CALLISIA L. in Loefl. It. Hisp. 305. 1758; C. B. Clarke, loc. cit. 309. 1881; Brückn. loc. cit. 173. 1930.

Hapalanthus Jacq. Select. Stirp. Amer. 11. *pl. 11.* 1763.

Spironema Lindl. Edwards's Bot. Reg. N. S. **3**: *pl. 47,* Miscel. 26. 1840; C. B. Clarke, loc. cit. 313. 1881; Brückn. loc. cit. 171. 1930.

Tradescantella Small. loc. cit. 238. 1903.

Rectanthera Degener, Fl. Hawai. **1**: 62. 1932.

CALLISIA **fragrans** (Lindl.) Woodson, comb. nov.

Spironema fragrans Lindl. loc. cit. 1840; C. B. Clarke, loc. cit. 1881; Brückn. loc. cit. 1930.

Rectanthera fragrans (Lindl.) Degener, Fl. Hawai. **1**: 62. 1932.

Aside from its gigantic size, the relationship of this species to the small creeping plants of *Callisia* should be sufficiently clear. The long runners by which *C. fragrans* propagates vegetatively probably are related phylogenetically to the creeping stems of the latter.

The remaining genera require little comment, as my views coincide with current interpretations of them. These studies still leave *Tradescantia* a large and rather complicated genus, although not as much so as formerly. Future studies may well restrict the genus even further, devoting particular attention to such tropical and subtropical groups as *T. micrantha* Torr., *T. commelinoides* R. & S. and their relatives, and the *T. fluminensis* Vell. complex.

A REVISION OF THE GENUS BUMELIA IN THE UNITED STATES[1]

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The genus *Bumelia* is the hardiest representative of the Sapotaceae in North America, occurring as far north as the lower valley of the Missouri River. It therefore differs from other members of this tropical and subtropical family in its adaptation to a temperate climate. The majority of species grow in mesophytic situations, although certain species have become well established in xerophytic habitats.

General Morphology

Bumelia is distinguished morphologically from other genera of the Sapotaceae in the structure of the flower and fruit, for example: (a) a pair of lateral appendages flank each corolla-lobe, (b) staminodia replace a cycle of stamens, and (c) the seeds are without albumen and exhibit a circular, basal hilum.[2]

Stem: The stems are sometimes armed with simple or branched spines. The bark is reddish-brown, appearing gray in age, while the branchlets in certain species are somewhat pubescent. The wood is singularly tough, becoming brittle in *B. angustifolia,* invariably yellowish, and very close-grained.[3] "Short-shoots," or brachyblasts, suggestive of certain gymnosperms, are frequently found in the leaf axils.

Corolla: The genus is characterized in part by the structure of its corolla, which is sympetalous through basal coalescence of the whitish petals to form a short tube. Each corolla-lobe bears a pair of lateral, petaloid appendages, thus constituting a pentamerous corolla with trifid lobes.[4]

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[1] An investigation carried out in the Graduate Laboratories of the Henry Shaw School of Botany of Washington University and submitted as a thesis in partial fulfillment of the requirements for the degree of master of science in the Henry Shaw School of Botany of Washington University.

[2] Baehni, C., in Candollea 7: 424. 1938.

[3] Record, S. J., in Trop. Woods 59: 26–27. 1939.

[4] A completely satisfactory evaluation of the various components of the flower of *Bumelia,* especially the lateral appendages of the corolla-lobes, has not become established. Students of the Sapotaceae have merely suggested the probable origin and relationship of the appendages: Hartog, M. M., On the floral structure and affinities of Sapotaceae. Jour. Bot. 16: 66. 1878; Lam, H. J., On the system of the Sapotaceae. Recueil Trav. Bot. Neerland. 36: 519. 1939.

Issued September 18, 1942.

Androecium: The five fertile stamens are epipetalous and opposite the lobes of the corolla. The anthers are attached to slender filaments and dehisce extrorsely by means of longitudinal slits. The staminodia, alternating with the fertile stamens, are petaloid and at an early phase of anthesis form a tube through which the filiform style emerges while the rapidly maturing stamens are enclosed by the yet unexpanded corolla.

Gynoecium: The pistil is pentacarpellary. The superior ovary bears a simple, erect, relatively short style surmounted by an inconspicuous stigma that becomes receptive before the corolla is completely unfolded. Normally, the outer wall of the ovary is hirsute, but this character is not constant throughout the genus, e. g., *B. reclinata.* Although the ovary bears five anatropous ovules (one in each locule), it is seldom that more than one develops.

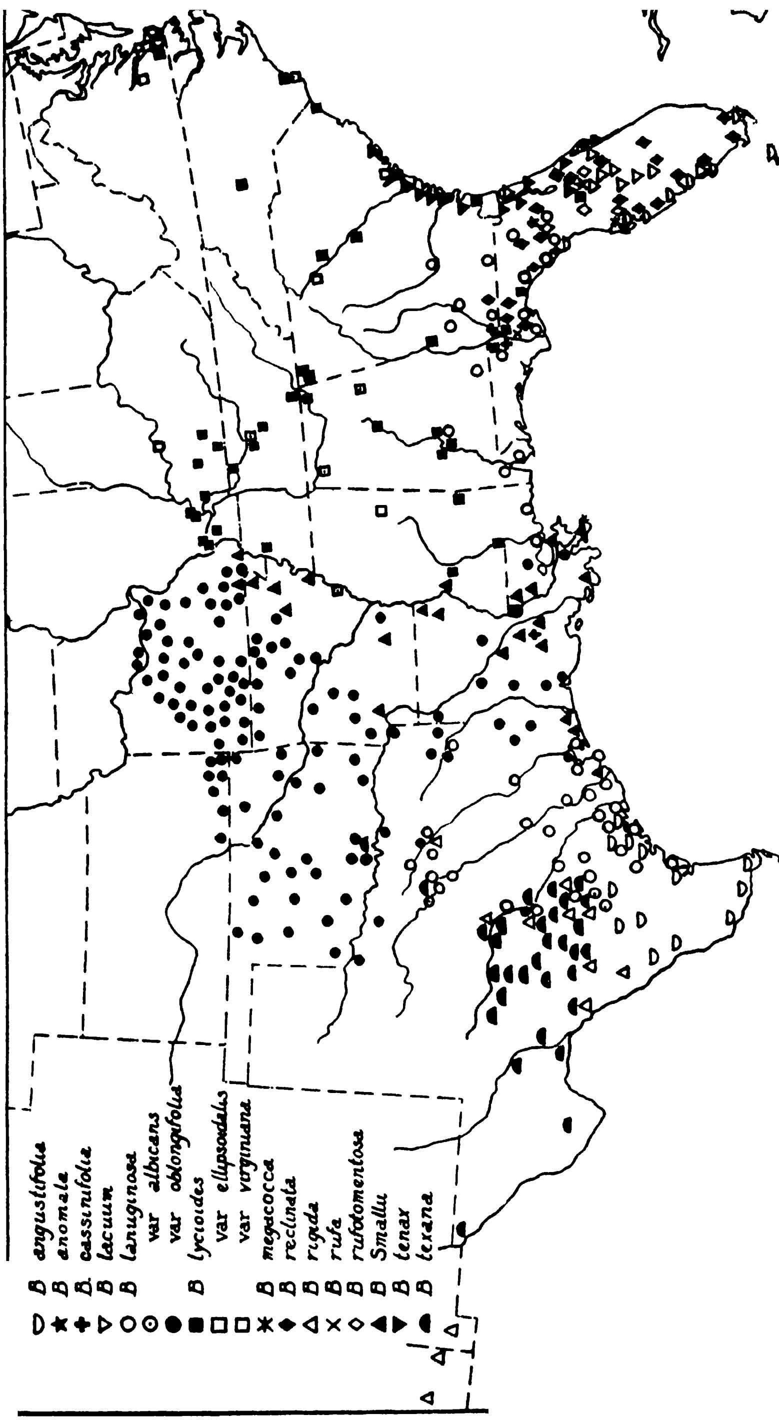
Fruit: The fruit is a single-seeded berry, enclosed in the fleshy wall of the ovary and often tipped by the persistent style. The berries are rather small, generally purplish-black when ripe, and edible.

Seed: The seeds are small with a hard, shiny, and oily testa which is generally brown though sometimes becoming variegated. The embryo is large, filling the cavity, while the radicle is barely evident; the cotyledons are thick, fleshy, usually consolidated, and albumen is wanting.

Geographical Distribution

Bumelia proves to be not only the hardiest genus of the Sapotaceae but also the most extensive. It ranges from the southeastern section of the country as far north as central Missouri and as far west as southeastern Arizona. The region of greatest diversity of species is centered in Florida, where eleven species occur, five being endemic. The greatest diversity of habitat is in Texas, where one species may be found growing in moist woodlands, while another inhabits only dry, sandy situations.

There are three natural groups of *Bumelia* in the United States. The first group consists of those species with lanuginose or sericeous pubescence on the branchlets, the under-surface of the leaves, the petioles, and the inflorescence, and includes *B. lanuginosa, B. tenax, B. lacuum, B. rigida,* etc. Except for the xerophytic species *B. rigida,* which occurs from southern Texas to southeastern Arizona, members of this group are chiefly mesophytic and inhabit sandy uplands, though not far removed from a source of water.



Map showing distribution of species of *Bumelia* throughout the United States.

They range from coastal South Carolina westward to southeastern Arizona, their distribution being interrupted by the lower Mississippi River Valley. Most widespread of these species is *B. lanuginosa,* which occurs in southern Georgia with two varieties extending from central Missouri to east-central Texas.

The second group is characterized by a tomentulose evanescent pubescence, and comprises such species as *B. lycioides, B. Smallii, B. reclinata,* etc. This group, except for *B. texana* which is found in the mountains or the dry, rocky plains of the Southwest, frequents more moist localities, occurring in the lower Mississippi River Valley, the Gulf and Atlantic coastal regions, and along water-courses as far north as southern Illinois and southeastern Virginia.

The third group is entirely glabrous or with only a few scattered hairs, and in this country *B. angustifolia* is its only representative. Plants of this species abound in the lower Rio Grande Valley of southern Texas, and are again found on the Keys and Gulf coast of Florida.

Acknowledgments

The writer takes this opportunity to express his appreciation to those who have so generously helped him in this study, especially to Mr. H. B. Parks, of the Texas Agricultural Experiment Station, for cooperation in making special collections, and to Mr. E. J. Palmer, of the Arnold Arboretum, for advice and criticism. Thanks are also due the curators of the herbaria from which specimens have been borrowed. These herbaria, with the abbreviations used in this paper, are as follows:

A—Arnold Arboretum, Harvard University.
G—Gray Herbarium, Harvard University.
L—Louisiana State University.
M—Missouri Botanical Garden.
NY—New York Botanical Garden.
P—Academy of Natural Sciences of Philadelphia.
Tr—S. M. Tracy Herbarium, Texas Agricultural Experiment Station.
Tu—Tulane University.
UO—University of Oklahoma.
US—United States National Herbarium.
UT—University of Texas.

TAXONOMY

Bumelia[5] Sw. Prodr. Veg. Ind. Occ. 49. 1788; Benth. & Hook. Gen. Pl. **2**: 660. 1876; Engler & Prantl, Nat. Pflanzenfam. **4**[1]: 145. 1891; Sarg. Silva **5**: 167. 1893.

Lycioides L. Hort. Cliff. 488. 1738.

Robertia Scop. Introd. Hist. Nat. 154. 1777.

Sclerocladus Raf. Sylva Tellur. 35. 1838.

Sclerozus Raf. Aut. Bot. 2: 73. 1840.

Lyciodes O. Ktze. Rev. Gen. **2**: 406. 1891.

Shrubs or small trees frequently with milky sap and spinescent branches. Leaves alternate or often fasciculate, simple, obovate to elliptic, entire, penninerved, short-petiolate, pubescent or glabrous beneath, usually coriaceous, deciduous or persistent. Flowers small, on rather short pedicels from the axils of scarious bracts, in many-flowered clusters from leaf-axils or from leafless nodes of the previous year, hermaphrodite, pentamerous, actinomorphic, hypogynous, proterogynous; calyx with 5 dimorphic, free sepals which are imbricate in aestivation and decurrent on the pedicel, persistent; corolla whitish, sympetalous, forming a short tube, the 5 lobes with pairs of lateral appendages; stamens epipetalous, 10 in 2 isomerous whorls—the fertile cycle opposite and equal in length to the corolla-lobes, the alternipetalous one reduced to petaloid staminodia; ovary 5-celled, generally hirsute, gradually or abruptly contracted into a filiform style stigmatic at apex, each locule with a solitary, anatropous ovule from the base of an axile placenta. Fruit a berry, oblong-ellipsoid or subglobose, blackish, often tipped by a persistent style; seed solitary with crustaceous, smooth, shiny, brownish testa, without albumen; embryo large, filling the cavity; cotyledons thick and fleshy.

Bumelia is confined to the New World, where it is distributed from central United States southward to Mexico, Central America, the West Indies, and South America as far as northern Argentina. Of the 35–40 species, 14 are found in the United States.

TYPE SPECIES: *Bumelia retusa* Sw. Prodr. Veg. Ind. Occ. 49. 1788.

KEY TO THE SPECIES

A. Branchlets (except in *B. anomala*), petioles, lower surface of leaves, and inflorescence conspicuously pubescent.

B. Pubescence woolly and lusterless.

[5] Internat. Bot. Kongr. in Wien, Verhandl. No. 6374 in list of Nomina Conservanda. Jena, 1906.

C. Leaves 2–10 cm. long, 1–4 cm. broad; flowers rather numerous.
D. Pubescence dense, rusty-tomentose; pedicels slender; seed oblong-obovoid, variegated....................................*1. B. lanuginosa*
DD. Pubescence dense, whitish-tomentose; pedicels slender; seed ellipsoid, brown..*1a.* var. *albicans*
DDD. Pubescence sparser than in species, whitish becoming tawny; pedicels stoutish; seed obovoid, brown......................*1b.* var. *oblongifolia*
CC. Leaves 1–4 cm. long, 0.5–1.5 cm. broad; flowers few..............*2. B. rigida*
BB. Pubescence sericeous and shiny.
C. Branches stout and spiny; leaves often small, not more than 4 cm. long; pubescence rufous.
D. Branchlets and lower surface of leaves densely tomentose; fruit obovoid, 8–10 mm. long...................................*3. B. lacuum*
DD. Branchlets densely tomentose, lower surface of leaves hairy only on midrib and veins; fruit subglobose, 4–6 mm. long......*4. B. rufotomentosa*
CC. Branches slender and nearly spineless; leaves rather large, usually more than 4 cm. long; pubescence silvery-white to tawny.
D. Leaves oblong-obovate to oblanceolate, cuneate at base; pedicels extremely slender, 8–13 mm. long............................*5. B. tenax*
DD. Leaves oblong-obovate to elliptic, obtuse at base; pedicels stout, 3–5 mm. long.
E. Branchlets glabrous, pale yellowish-gray; leaves shiny and pale green above, silvery beneath...............................*6. B. anomala*
EE. Branchlets very tomentose, red or reddish-brown; leaves dull and dark green above, tawny beneath.........................*7. B. rufa*
AA. Branchlets, petioles, lower surface of leaves, and inflorescence with few inconspicuous hairs generally scattered along midrib; or entirely glabrous.
B. Leaves puberulous or glabrate; fruit obovoid or subglobose (except in *B. lycioides* var. *ellipsoidalis*).
C. Leaves elliptic, generally broadest at middle.
D. Leaves 1.5–13.5 cm. long, obtuse to acuminate at apex (except var. *virginiana*)...*8. B. lycioides*
E. Leaves rounded at apex; corolla-tube shorter than in species; fruit obovoid....................................*8a.* var. *virginiana*
EE. Leaves acute to acuminate at apex; corolla-tube same length as in species; fruit ellipsoid.........................*8b.* var. *ellipsoidalis*
DD. Leaves 2–5 cm. long, acute to occasionally rounded at apex.....*9. B. Smallii*
CC. Leaves obovate or spatulate, mainly broadest above middle.
D. Leaves thinnish; corolla-lobes erose; seed usually not variegated.
E. Fruit 4–6 mm. long; seed occasionally variegated; ovary glabrous ....*10. B. reclinata*
EE. Fruit 8–12 mm. long; seed not variegated; ovary hirsute.......... ....*11. B. cassinifolia*
DD. Leaves coriaceous; corolla-lobes entire; seed variegated.
E. Leaves 1–7 cm. long; fruit obovoid, 8–10 mm. long......*12. B. texana*
EE. Leaves 1–3.5 cm. long; fruit subglobose, 10–13 mm. long.......... ....*13. B. megacocca*
BB. Leaves glabrous; fruit ellipsoid-cylindrical.................*14. B. angustifolia*

1. Bumelia lanuginosa (Michx.) Pers. Syn. **1**: 237. 1805; DC. Prodr. **8**: 190. 1844; Nutt. Sylva **3**: 36. 1849; Sarg. Silva **5**: 171, *pl. 247*. 1893, *pro parte*.

Sideroxylon tenax Walt. Fl. Car. 100. 1788, non L.
Sideroxylon lanuginosum Michx. Fl. Bor. Am. 1: 122. 1803.
? *Chrysophyllum ludovicianum* Raf. Fl. Ludovic. 53. 1817.
Lyciodes lanuginosum O. Ktz. Rev. Gen. 2: 406. 1891.

Shrub or small tree, 3–7 m. high; branchlets, petioles, lower surface of leaves, and inflorescence covered with lusterless tomentum at first pale, becoming reddish-brown; stems with reddish-gray bark, armed occasionally with short stout spines; leaves narrowly oblong-obovate, rarely elliptic, 2–10 cm. long, 1–4 cm. broad, round to acute or sometimes mucronate at apex, cuneate at base, dark green and lustrous above, thin and firm at maturity; petioles 2–15 mm. long; flowers disposed in few- to many-flowered fascicles; pedicels 8–12 mm. long, greatly enlarged towards apex; sepals broadly obovate to suborbicular, rounded at apex; corolla-lobes broadly ovate to elliptic, appendages ovate-lanceolate, acute; staminodia ovate-elliptic, obtuse at apex, erose, nearly as long as the petals; fruit purplish-black, oblong-ellipsoid, 6–10 mm. long, frequently tipped by a persistent style; seed oblong-obovoid, 5–8 mm. long, variegated tan and brown.

Distribution: in sandy uplands and along streams, southwestern Georgia and adjacent Florida, westward to southeastern Louisiana.

Specimens examined:

GEORGIA: precise data lacking, *Michaux s.n.* (Mus. Paris, TYPE; G, fragment). DECATUR Co.: near Bainbridge: *Curtiss 1762*, in part (A), *Harbison 15, 1127* (A). DOUGHERTY Co.: along Flint R. at Albany: May 24-28, 1895, *Small* (A), *Harbison 14* (A); Dr. Gillespie's Pocoson Place, *Gillespie 4956* (A). RANDOLPH Co.: Cuthbert, *Harbison 6* (A). TELFAIR Co.: Lumber City, *Harbison 16* (A). TERRELL Co.: banks of Kinckafoonee Cr., *Harper 1153* (G, M).

FLORIDA: exact locality unknown, *Chapman* (G, M, P); "N.W. Fla.", *Curtiss 35* (G). ALACHUA Co.: Gainesville, *Seibert 1412, 1412a* (M). COLUMBIA Co.: Lake City: *Nash 2167* (A, G, M), *Wiegand & Manning 2486* (G). DIXIE Co.: Old Town, *Harbison 12* (A). FRANKLIN Co.: banks of Chattahoochee R., above Apalachicola: *Biltmore Hb. 1688*, coll. by Chapman (A, G, M), *Saurman* (P); Carrabelle, *Harbison 23, 27* (A). JACKSON Co.: Marianna: *Harbison 14, 29* (A), *Palmer 35301* (A, M, P). LEVY Co.: Cedar Keys, *Tracy 7464* (A, G, M). WAKULLA Co.: Wakulla Springs, *Harbison 1216* (A, M). TAYLOR Co.: Hampton Springs, *Palmer 38474* (A, M).

ALABAMA: locality not given: *Beck* (P), *Cabell* (G). BALDWIN Co.: Fairhope, *Jack 3026* (A); Perdido, *Mohr 47* (A). DALE Co.: near Ozark, *Palmer 38653* (A, M). DALLAS Co.: Selma, *Harbison 96, 829, 1095, 1111* (A). MOBILE Co.: Mt. Vernon, *Harbison 7* (A).

MISSISSIPPI: HARRISON Co.: Mississippi City, *Harbison 3* (A); Stabilized Beach, Cat Isl., Apr. 19, 1931, *Penfound* (Tu).

LOUISIANA: ST. TAMMANY Parish: Slidell, Aug. 1899, *Cocks* (A).

B. lanuginosa is limited in its distribution; it seems to be related to *B. tenax* but is distinguished by its sparser, woolly pubescence

(which in *B. tenax* is sericeous), its generally larger and broader leaves, and its fewer-flowered inflorescence.

1a. Bumelia lanuginosa var. **albicans** Sarg. in Jour. Arn. Arb. 2: 168. 1922.

Bumelia arborea Buckl. in Proc. Phil. Acad. **13**: 461. 1861.

Small tree to 20 m. high, with branches rarely armed; pubescence dense, whitish, lusterless, appressed at first, becoming woolly; leaves somewhat narrower than in species; petioles 5–15 mm. long; inflorescence many-flowered; pedicels slender, 5–13 mm. long; sepals reniform to elliptic; corolla-lobes oblong-elliptic; margins of appendages crenulate; staminodia oblong-elliptic, rounded and somewhat cucullate at apex; ovary subglobose, abruptly contracted into an elongated style; fruit ellipsoid to oblong-obovoid, 8–12 mm. long; seed ellipsoid, brown with tuberculate apex.

Distribution: in sandy river-bottoms and rocky uplands, east-central Texas, and adjacent Mexico.

Specimens examined:

TEXAS: "S. Tex.", *Buckley* (P, type of *B. arborea*, G, fragment). ATASCOSA Co.: s. of San Antonio on road to Corpus Christi, *Buckley* (A); Campbelton, *Palmer 11242* (M). BEXAR Co.: San Antonio: *Bush 802* (A, M), Hildebrandt Rd., *Clark & Parks 567* (M); Swearingen Ranch, *Schulz 49* (A). BOSQUE Co.: Meridian, June 29, 1927, *Tharp* (UT). BRAZORIA Co.: Brazos R., Brazoria, *Palmer 6741* (A, M); Columbia: *Bush 1, 2, 3, 210, 226, 877, 1427, 1524* (M), *Palmer 5050* (A); Velasco, *Palmer 13131* (A, M). BRAZOS Co.: Bryan, *Palmer 11739* (A, M); near Neleva, *Palmer 13446* (A, M). CALHOUN Co.: Indianola, *Cory 11618* (A); Wolf Pt., *Tharp 1431* (UT). CHAMBERS Co.: Apr. 8, 1936, *Tharp* (UT). COMAL Co.: Brazos R. bottoms, *Lindheimer 90* (M); New Braunfels, *Lindheimer 269*, in distribution as no. *979* (A, G, M, P, UO, UT). DALLAS Co.: Dallas: *Reverchon 384* (G), *590* (A, M), June 22, 1899, *Eggert* (M), Nov. 21, 1913, *Sudworth* (A). ERATH Co.: Stephenville, *Palmer 14176* (A, M). FT. BEND Co.: Brazos R., Richmond, *Palmer 4943* (A). GALVESTON Co.: Galveston Isl., May 1843, *Lindheimer* (M). GOLIAD Co.: Goliad: Apr. 8, 1900, *Eggert* (M), along San Antonio R., near La Bahia Mission, *Clark & Parks 574* (M). GONZALES Co.: Halff Ranch, Mar. 3, 1940, *Parks* (Tr); Ottine Swamp, *Cory 5770* (A). HARRIS Co.: Houston: June 1842, Aug. 1843, *Lindheimer* (M), June 16, 1903, *Reverchon* (M), June 4, 1915, *Fisher* (M), *Palmer 11456* (A, M). JACKSON Co.: E. Karankawa Pt., *Tharp 1424* (UT). LAMPASOS Co.: Lampasos, Mar. 21, 1911, *Sargent* (A). LLANO Co.: Enchanted Rock, June 11, 1930, *Tharp* (UT). MATAGORDA Co.: Peyton's Cr., *Palmer 9734* (A, M). NAVARRO Co.: Corsicana, *Reverchon 3194* (M); near Dawson, *Reverchon 3867* (M). NUECES Co.: Nuecestown, Apr. 27, 1896, *Marlatt* (US). PALO PINTO Co.: Strawn, *Palmer 14266* (A, M). RUSK Co.: Henderson, July 30, 1927, *Tharp* (UT). SAN SABA Co.: San Saba, *Palmer 11844* (A). SOMERVILLE Co.: Squaw Cr., above Glen Rose, Oct. 9, 1891, *Ward* (US). TARRANT Co.: Caddo Cr. bottoms, near Handley, Sept. 23, 1902, *Reverchon* (M); near Ft. Worth, *Ruth 202* (G, M, P). TRAVIS Co.: Austin: Apr. 1860, *Buckley* (M), *Mohr 12* (A), *Mohr 623* (US), Mar. 29, 1885, *Sargent* (A), *Schostag 3002* (UT), *McKee & Wesley 3834* (UT), *Parker 4791* (UT), *N. Y. State College of Forestry, Proj. I, 8269*, coll. by Tharp (A), *Schulz 2434* (A). VICTORIA Co.: Guadalupe R. bottoms, Victoria: Apr. 9, 1915, *Sargent* (A, TYPE), *Palmer 9104* (A, M).

WALKER Co.: Huntsville, *Dixon 403* (G). WALLER Co.: Hempstead, *Hall 394* (G, M). WHARTON Co.: banks of Colorado R., Wharton, *Palmer 4902* (A). WILSON Co.: *Parks & Cory 7791* (Tr); Sutherland Springs: Oct. 1910, *Mackenson* (A), Apr. 8, 1915, *Sargent* (A), *Palmer 9209* (A, M), *Cutler 858* (M).

MEXICO: NUEVO LEON: near Monterrey, Apr. 6, 1887, *Sargent* (A).

Tallest of the Bumelias in the United States, *B. lanuginosa* var. *albicans* is limited in distribution and is easily recognized by its rather dense, whitish pubescence.

1b. Bumelia lanuginosa var. **oblongifolia** (Nutt.) Clark, comb. nov.

Bumelia oblongifolia Nutt. Gen. **1**: 135. 1818; Sylva **3**: 33. 1849.

Bumelia arachnoidea Raf. New Fl. N. Am. 3: 28. 1836.

Bumelia tomentosa A. DC. in DC. Prodr. **8**: 190. 1844.

Armed shrub or small tree; pubescence rather sparse, dull, whitish, becoming tawny; leaves obtuse to rounded or somewhat retuse at apex, broadly cuneate at base; petioles 2–10 mm. long; flowers numerous; pedicels 5–8 mm. long; sepals suborbicular to oblong-ovate or elliptic; corolla-lobes oblong-ovate; ovary subglobose, abruptly contracted into the style; fruit broadly elliptic-ovate; seed obovoid, brown.

Distribution: in dry, rocky uplands, southern Missouri and southeastern Kansas to Louisiana and eastern Texas.

Specimens examined:

MISSOURI: BARRY Co.: Eagle Rock: *Bush 182, 3130* (M); Roaring R., *Trelease 1117* (M). BENTON Co.: along Cole Camp Cr.: *Demetrio 47* (G), *Trelease 430* (M), *Palmer 30067* (A, M); along Osage R.: near Fredonia, *Palmer 35956* (A, M), near Warsaw, *Palmer 36769* (A, M). BOONE Co.: Missouri R. bluffs above Wilton P. O., *Jeffrey 307* (M). CALLAWAY Co.: along Stinson Cr., s.w. of Fulton, *Steyermark 26076* (M). CARTER Co.: Club House, *Trelease 427* (M); along Big Barren Cr., s.e. of Fremont, *Steyermark 11888* (M). CEDAR Co.: along Sac R., n.e. of Stockton, *Steyermark 13479* (M). CHRISTIAN Co.: Swan Cr., s.e. of Chadwick, *Steyermark 22991* (M). COLE Co.: near Brazito, *Palmer 39227* (A, M); near Jefferson City, *Palmer 39231* (A). COOPER Co.: *Bush 13654, 13893* (A). DADE Co.: near Turnback, *Palmer 35595* (A, M). DALLAS Co.: along Niangua R., s. of Windyville, *Steyermark 13737* (M). DOUGLAS Co.: between Roosevelt and Richville, *Steyermark 14693* (M). FRANKLIN Co.: July-Aug. 1835, *Meyer* (M); Catawissa, July 26, 1887, *Eggert* (G, M); Pacific, *Greenman 3898* (M); along Meramec R., Meramec State Pk., Sullivan, *Steyermark 1492* (M). GREENE Co.: near Springfield, *Palmer 30148* (A, M). HENRY Co.: along Grand R., n.e. of Finey, *Steyermark 15964* (M). HICKORY Co.: along Pomme de Terre R., near Hermitage, *Palmer 35983* (A, M). IRON Co.: near Ironton, *Palmer 22642* (A). JASPER Co.: Carterville, *Palmer 2655, 18318* (A); Carthage, *Bush 10390* (A, G, M); Muddy Cr., Golden City, *Palmer 4585* (A, M); near Jasper, *Palmer 28931* (A, M); near Joplin: *Trelease 433* (M), *Palmer 22730, 23366, 26316* (A); Neck, *Palmer 15723* (A); Spring R., *Trelease 1116* (M); near Waco, *Palmer 18483* (A); Webb City, *Palmer 28, 927, 14291* (M). JEFFERSON Co.: De Soto, July 25, 1887, *Hasse* (M); s.e. of Pacific, *Steyermark 1270* (M); Victoria, May 10 and July 8, 1890, *Hitchcock* (M).

LAWRENCE Co.: near Red Oak, *Palmer 26980* (A, M). MADISON Co.: near Fredericktown, *Palmer 31628, 31639* (A). MARIES Co.: Lanes Prairie, *Bush 13470* (A). MCDONALD Co.: *Bush 236* (G, M); Noel: *Bush 4978, Palmer 4264, 5491, 14660, 14664* (A, M). MILLER Co.: Bagnell, *Trelease 426* (M); near Tuscumbia, *Palmer 39220* (A, M). MONITEAU Co.: between California and Jamestown, *Steyermark 14758* (M). MORGAN Co.: *Bush 13596, 13691* (A, M); along Proctor Cr., *Steyermark 13181* (M). OSAGE Co.: along Maries R., w. of Westphalia, July 14, 1933, *Jeffrey* (A). OZARK Co.: near Bakersfield, *Palmer 32819* (A, M); ''Bald Jesse'' near Gainesville, *Palmer 34761* (A, M). PETTIS Co.: *Bush 13628* (A, M). PHELPS Co.: ''Slaughter Sink'' near Arlington, *Palmer & Steyermark 41399* (A, M); Jerome, *Kellogg 388* (A, M). POLK Co.: along Pomme de Terre R.: n. of Burns, *Steyermark 13630* (M), Buzzards Den, n.w. of Pleasant Hope, *Steyermark 24108* (M). PULASKI Co.: Big Piney R., *Trelease 429* (M). RIPLEY Co.: Bay Mills, *Mackenzie 392* (M). ST. CHARLES Co.: Meramec R. at St. Pauls, 25 mi. w. of St. Louis, Nov. 2, 1854, *Engelmann* (G, M). ST. CLAIR Co.: along Osage R.: near Osceola, *Palmer 35646* (A, M, P), n. of Oyer, *Steyermark 20237* (M). ST. FRANCOIS Co.: Bismarck, *Palmer 18055* (A, M); Flat River, *Trelease 431, 432* (M). ST. LOUIS Co.: July 26, 1886, *Eggert* (A, US); Allenton: 1876–1911, *Letterman* (M, P, US), July 29, 1887, *Eggert* (M); Big Bend, Meramec R., *ex Glatfelter Hb. 308* (M); near Glencoe and Valley Park, July 18, 1879, *Eggert* (M); Meramec Highlands: 1874, *Letterman* (M), July 28 and Sept. 6, 1886, *Eggert* (M, UT), June 25, 1904, *Gleason* (G), *Bartram 2425* (P); Pleasant Grove, *Bush 262* (M). SHANNON Co.: *Bush 956* (M); Montier: *Bush 171, 704, 1138* (M), *Palmer 19390* (A, M). STODDARD Co.: n. of Puxico, *Steyermark 11641* (M). STONE Co.: near Galena: *Palmer 4641, 5772, 5860, 5862, 14360, 22860, 24601, 26136* (A); ''White Rock Bluff,'' White R., *Palmer 5857* (A, M). TANEY Co.: Swan Cr., *Trelease 428* (M). WASHINGTON Co.: near Irondale, *Palmer 30172* (A, M). WAYNE Co.: Williamsville, *Palmer 6113* (A, M). WEBSTER Co.: headwaters of James R., *Engelmann 53* (M); near Niangua, *Palmer 39504* (A, M, P). WRIGHT Co.: *Bush 905* (M).

ARKANSAS: complete data lacking, *Nuttall s.n.* (P, TYPE), June 7, 1854, *Beyrich* (M). BENTON Co.: Twin Mt. and Osage R., *Demaree 4563, 4614* (M); near Monte Ne, *Palmer 24749* (A, M). BOONE Co.: Harrison, *Palmer 6917* (A). CARROLL Co.: Beaver, *Palmer 6330* (A, M); near Eureka Springs, *Palmer 20472* (A). CLARK Co.: Amity, *Demaree 10017* (M); Arkadelphia, *Palmer 10536* (A); Okolona, *Demaree 16100* (M). DREW Co.: Tillar, *Demaree 19281* (M). FAULKNER Co.: *Demaree 99* (M); Mammoth Springs, *Demaree 5294* (M). GARLAND Co.: near Hot Springs, *Palmer 23083, 29075* (A, M). HOT SPRINGS Co.: Magnet Cave, *Palmer 26565* (A). IZARD Co.: along White R., near Calico Rock, *Palmer 35553* (A, M). JACKSON Co.: Newport: May 5, 1881, *Letterman* (A, M), *Palmer 35533* (A, M). LOGAN Co.: Magazine Mt., *Palmer 24165* (A, M). MARION Co.: bluffs of White R., Cotter, *Palmer 5915, 14328* (M). MONTGOMERY Co.: bottoms of Caddo Cr., Norman, *Demaree 9561* (M). POPE Co.: near Nogo, *Merrill 88* (A, M, NY). PULASKI Co.: Little Rock: 1880, *Harvey* (M), banks of Arkansas R., *Palmer 22929* (A, M); Palarm, *Demaree 8716* (A); Maumelle Mt., Pinnacle, *Palmer 23015* (A). SALINE Co.: banks of Saline R., near Benton, *Demaree 8496* (A). SEVIER Co.: Horatio, *Palmer 8389* (A, M). VAN BUREN Co.: near Shirley, *Palmer 24314* (A, M).

LOUISIANA: exact locality lacking, *Hale* (G, P). CADDO Parish: Shreveport, July 1909, *Dickson* (Tu). CALCASIEU Parish: Lake Charles: Apr. 13, 1915, *Sargent* (A), *Palmer 7699* (A, M). CAMERON Parish: Cameron, *Palmer 8536* (A, M). LA SALLE Parish: Standard, Sept. 1, 1927, *Whitehead* (L). NATCHITOCHES Parish: Natchitoches, *Palmer 7468, 8022, 8763* (A, M). ORLEANS Parish: New Orleans, 1832, *Drummond 207*, in part (G, cotype of *B. tomentosa*). TANGIPAHOA Parish: Hammond, May 1910, *Cocks* (Tu). VERNON Parish: Leesville, *Brown 6869, 6872* (L).

KANSAS: CHAUTAUQUA Co.: along Middle Caney Cr., near Sedan, *Palmer 41809* (A, M). CHEROKEE Co.: *Black 757* (G, M); near Galena, *Palmer 20884, 21982, 25339* (A). COWLEY

Co.: Arkansas City, *Palmer 21244, 22072* (A). CRAWFORD Co.: near Pittsburg, *Palmer 20826* (A). LA BETTE Co.: w. of Oswego, *Rydberg & Imler 317* (M). NEOSHO Co.: Ladore, Nov. 15, 1893, *Hart* (P). WILSON Co.: near Neodesha, *Palmer 21160, 22030* (A).

OKLAHOMA: BLAINE Co.: Canton, *Andrews 20* (A). CANADIAN Co.: Devils Canyon, e. of Hinton: *Little 3911* (A, UO), *Hopkins 2108* (UO). CHEROKEE Co.: e. of Tahlequah, *Little 477* (UO). CHOCTAW Co.: Ft. Towson, *Palmer 8308* (A, M). CLEVELAND Co.: near Norman: Aug. 20, 1924, *Braner* (A, US), *Felkner 11* (UO), *Stacy 107* (UO). COMANCHE Co.: Boulder Camp, Wichita Nat. Forest, *Demaree 13180* (UO). CUSTER Co.: Clinton, *Palmer 12559* (A, M). GARFIELD Co.: n.w. of Enid, *Brigham 11* (UO). GREER Co.: s.e. of Granite, *Bull 248* (UO). JOHNSON Co.: Tishomingo, *Palmer 6416* (A, M). KIOWA Co.: near Mountain Pk., *Stevens 1261½* (A, G). LE FLORE Co.: near Page: *Stevens 2628* (A, G), *Palmer 20556* (A); Poteau, *Palmer 8266, 8267* (A, M). MAJOR Co.: Cleo, *Stevens 1720* (G, M). MCCURTIN Co.: s. of Bethel, *Hopkins & Cross 2543* (UO). MCLAIN Co.: w. of Purcell, *Hopkins 1187* (UO). MURRAY Co.: Arbuckle Mts., *Hopkins 2750* (UO); Davis, *Emig 658* (M); Platte Nat. Pk., near Sulphur, *Merrill 908* (A), *1724* (M). MUSKOGEE Co.: Muskogee, *Palmer 11198* (A, M). OKLAHOMA Co.: Oklahoma City, *Palmer 14610, 22107* (A). OTTAWA Co.: Commerce, *Bush 9266, 10148* (A). PAYNE Co.: near Perkins, Oct. 3, 1896, *Bogue* (P); s.w. of Stillwater, *Spears 113* (UO). ROGER MILLS Co.: near Antelope Hills, *Bigelow 678* (G). TULSA Co.: along Arkansas R., *Bush 491* (A, G, M); near Fisher, *Stevens 2960-E* (G). WASHINGTON Co.: Copan, *Stevens 2154* (A, G). WOODS Co.: s.w. of Waynoka, *Jackson 340* (UO). WOODWARD Co.: near Woodward, *Palmer 41927* (A, M).

TEXAS: ANGELINA Co.: Pine Island, May 5, 1903, *Reverchon* (M); Jack Cr., July 25, and Haw Cr., Aug. 12, 1934, *Boon* (UT). ARCHER Co.: Diversion Lake, *Cory 13227* (A). BOWIE Co.: near Texarkana, *Heller & Heller 4242* (A, M, NY, US). GREGG Co.: n. of Longview, June 7, 1899, *Eggert* (M). DALLAS Co.: Dallas, *Bush 1619* (A, M). GRAYSON Co.: Denison, *Palmer 14273* (A, M). HARDEMAN Co.: n. of Chillicothe, *Parks & Cory 13368* (Tr), *Cory 13369* (A). HARRIS Co.: Houston, *Palmer 11927* (A, M). HARRISON Co.: Marshall, *Palmer 13226* (A, M). LLANO Co.: Enchanted Rock, Sept. 1, 1930, *Whitehouse* (UT). POLK Co.: Livingston, *Palmer 5262* (A, M). RUSK Co.: Tatum, Oct. 10, 1902, *Reverchon* (M). SAN AUGUSTINE Co.: San Augustine, *Palmer 7892, 7894* (A,M).

The most widespread element in the *B. lanuginosa* complex, var. *oblongifolia* differs from the species in its rather sparse pubescence and shorter pedicels.

2. **Bumelia rigida** (Gray) Small in Bull. N. Y. Bot. Gard. **1**: 444. 1900; Britt. N. Am. Trees, 780, *fig. 711.* 1908; Wooton & Standl. in Contrib. U. S. Nat. Herb. **19**: 495. 1915.

Bumelia spinosa S. Wats. in Proc. Am. Acad. **18**: 112. 1883, non A. DC.

Bumelia lanuginosa var. *rigida* Gray, Syn. Fl. N. Am., ed. 2, **2**^{1}: 68. 1886.

Bumelia pauciflora Engelm. ex Gray, Syn. Fl. N. Am., ed. 2, **2**^{1}: 68. 1886, non Roem. & Schult.

Armed shrub or small tree, 6–8 m. tall; branches numerous, short, spinescent, clothed in reddish or grayish bark; branchlets, lower surface of leaves, petioles, and inflorescence densely covered with

pale tomentum; leaves numerous, coriaceous, small, obovate to cuneate-oblanceolate, 1–4 cm. long, 0.5–1.5 cm. broad; flowers few; pedicels stout, 2–5 mm. long; sepals oblong-elliptic to suborbicular; corolla-lobes suborbicular, truncate at base, margins erose; appendages lanceolate to ovate-lanceolate, acute at apex, margins erose; staminodia ovate-lanceolate, obtuse at apex, margins erose; ovary cylindrical, abruptly contracted into a slender, elongated style; fruit obovoid to subglobose, 6–9 mm. long, purplish-black, short style often persistent; seed obovoid to subglobose, 3–6 mm. long, frequently narrowed at base, variegated, dark brown and pale tan.

Distribution: near streams on dry, gravelly mountain slopes, south-central Texas, westward to southeastern Arizona, and adjacent Mexico.

Specimens examined:

TEXAS: BEXAR Co.: San Antonio, *Clemens & Clemens 889* (M). DUVAL Co.: San Diego, Apr. 1882, *Buckley* (A). KERR Co.: Lacey's Ranch, *Schulz 36* (US). LLANO Co.: Harris, *Parks & Cory 6271* (Tr). NUECES Co.: Corpus Christi, Mar. 26, 1907, *York* (UT). UVALDE Co.: Uvalde, July 1879, *Edw. Palmer 156* (G, TYPE, US). VALVERDE Co.: Devils R., *Palmer 11367* (A, M).

NEW MEXICO: Dier Cr., June 20, 1906, *Wooton* (US); Dog Spring, Dog Mts., *Mearns 2351, 2356* (US); San Bernardino R., *Mearns 2545* (US). HIDALGO Co.: Animas Valley, s. of Animas, *Wolf 2580* (G).

ARIZONA: COCHISE Co.: Camp Bowie, *Lemmon 200* (G); Guadalupe Canyon, e. of Douglas, *Peebles 11698* (US); Ft. Bowie: June 25, 1894, *Fisher* (US), *Blumer 2298* (NY); near Gleeson, *Shreve 5382* (A, G, US); Chiricahua Mts., near Paradise: *McKelvey 605* (A, US), Turkey Cr., May 27, 1906, *Holmes* (US), Whitetail Cr., Dec. 1908, *Sudworth* (US); Swisshelm Mts., July 21, 1894, *Toumey* (A, NY). PIMA Co.: Santa Catalina Mts., June 16, 1881, *Pringle s.n.* (M, type of *B. pauciflora*, A, G, US); Bear Cr., Tucson, *Eastwood 8164* (A); Baboquivari Canyon, *Peebles, Harrison & Kearney 388* (US).

MEXICO: COAHUILA: Saltillo, *Palmer 232* (A).

B. rigida seems to be composed of two elements. One of these may possibly be a variety of *B. lanuginosa* that has adapted itself to the conditions of soil and climate of the Southwest: in its pubescence it resembles *B. lanuginosa* var. *albicans,* while in its fruit and pedicels it looks like *B. texana.* However, it seems advisable not to attempt any segregation until more material is available.

3. **Bumelia lacuum** Small, Man. S. E. Fl. 1034. 1933.

Armed evergreen shrub, 0.5–3 m. tall; branchlets, petioles, lower surface of leaves, and inflorescence densely covered with lustrous, appressed, rufous pubescence; leaves oblong-obovate to spatulate, 1–4 cm. long, 1–3 cm. broad, obtuse at apex, cuneate at base, mar-

gins slightly revolute; petioles 1–4 mm. long; sepals and corolla-lobes oblong-elliptic; corolla-tube short, lobes scarious, appendages ovate-lanceolate, acute at apex; staminodia ovate-elliptic, obtuse at apex, margins slightly crenulate; ovary subglobose, abruptly contracted into the style; fruit oblong- to elliptic-obovoid, 8–10 mm. long; seed elliptic-obovoid, 6–8 mm. long, pale tan.

Distribution: sandhills, usually in scrub, central peninsular Florida.

Specimens examined:

FLORIDA: exact locality unknown, *Rugel 161* (M); "E. Fla.", *Buckley* (G). BREVARD Co.: Indian R., *Palmer 326* (G, M). COLLIER Co.: Caxambas Isl., *Simpson 578* (G). COLUMBIA Co.: Lake City, *Rolfs 46* (M). DUVAL Co.: near Jacksonville, *Curtiss 1762'* (M). HIGHLANDS Co.: between Avon Park and Sebring: *Small & DeWinkeler 9042* (NY), Aug. 30–31, 1922, *Small, Small & DeWinkeler 10666*[6] (NY, fr. part of TYPE), *10755* (NY); n. of Kuhlman, Apr. 25, 1921, *Small & DeWinkeler 9965* (NY, fl. part of TYPE, G); near Sebring: *Harbison 29, 37* (A), *Palmer 27438* (A, M). LAKE Co.: near Eustis: *Hitchcock* (M), *Nash 818* (A, G, M, NY), *Harbison 9* (A). ORANGE Co.: e. of Maitland, *Baker 513* (A); edge of L. Apopka hammock, w. of McDonald, *Baker 504, 505, 506, 507, 508, 509, 510, 511a,b,z, 512a,b,z, 514, 515, 525, 544* (A); near Plymouth, *Palmer 38350* (A, M). OSCEOLA Co.: Kissimmee, Aug. 2, 1929, *O'Neill* (US). POLK Co.: near Bartow, *Palmer 38366* (A), near Frostproof, *Palmer 27385* (A); Winter Haven, *McFarlin 6678* (UT). SEMINOLE Co.: Oviedo, *Harbison 8, 9* (A).

B. lacuum is segregated from *B. tenax* because of its dwarfness. Also the pubescence is rufous and less lustrous.

4. **Bumelia rufotomentosa** Small in Bull. N. Y. Bot. Gard. **1**: 440. 1900, as *rufomentosa;* Man. S. E. Fl. 1033. 1933.

Armed shrub less than 1 m. high; branchlets and petioles densely covered with rufous tomentum; leaves coriaceous, obovate or oval, 1.5–4 cm. long, 0.5–3 cm. broad, rounded to slightly retuse at apex, cuneate at base, sparingly pubescent beneath; petioles very short, 1–3 mm. long; flowers few; pedicels 3–5 mm. long; sepals oblong-elliptic to suborbicular; corolla-lobes suborbicular, appendages ovate-lanceolate, obtuse at apex; staminodia ovate, acute at apex; ovary subglobose, gradually contracted into a stout style; fruit subglobose, 4–6 mm. in diameter.

Distribution: in pine woods, peninsular Florida.

Specimens examined:

FLORIDA: ALACHUA Co.: Gainesville, *Seibert 1411* (M). HILLSBOROUGH Co.: Tampa, May 1876, *Garber* (NY, TYPE, US). ORANGE Co.: Zellwood, *Baker 503a,b,c,z* (A). SUMTER Co.: Sumterville, *Curtiss 1764* (A, G).

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[6] *Small, Small & DeWinkeler 10666* distributed as "*Bumelia tenax* Willd." is apparently *Dipholis salicifolia* (L.) DC.

This species is possibly a pubescent form of *B. reclinata*, but it is recognized here as a separate species because of its rufous-tomentose branchlets and its villous ovary.

5. **Bumelia tenax** (L) Willd. in L. Sp. Pl. **1**²: 1085. 1798; Loud. Arb. & Frut. Brit. **2**: 1193, *fig. 1017*. 1838; DC. Prodr. **8**: 190. 1844; Nutt. Sylva **3**: 35, *pl. 92*. 1849; Sarg. Silva **5**: 169, *pl. 246*. 1893; Small in Bull. N. Y. Bot. Gard. **1**: 446. 1900.

Sideroxylon tenax L. Mant. 48. 1767, non Walt.

Chrysophyllum carolinense Jacq. Obs. 3: 3, *pl. 54*. 1768.

Sideroxylon sericeum Walt. Fl. Car. 100. 1788.

Sideroxylon chrysophylloides Michx. Fl. Bor. Am. **1**: 123. 1803.

Bumelia chrysophylloides Pursh, Fl. Am. Sept. **1**: 155. 1814; P. W. Wats. Dendr. Brit. **1**: 10, *pl. 10*. 1825.

Sclerocladus tenax Raf. Sylva Tellur. 35. 1838.

Sclerozus tenax Raf. Aut. Bot. 2: 73. 1840.

Bumelia reclinata Chapm. Fl. Southeast. U. S. 275. 1860, non Vent. nec Torr.

Lyciodes tenax O. Ktz. Rev. Gen. **2**: 406. 1891.

Shrub or small tree, 2–10 m. high; branchlets, petioles, lower surface of leaves and inflorescence densely covered with a tawny pubescence; branchlets slender, with reddish-brown bark, occasionally armed with stout spines, 2–2.5 cm. long; leaves oblong-obovate to oblanceolate, 2–7 cm. long, 0.5–3.5 cm. broad, obtuse at apex, cuneate at base, margins slightly revolute, midvein prominent; petioles 2–9 mm. long; inflorescence many-flowered; pedicels slender, 8–13 mm. long, slightly enlarged toward apex; sepals oblong-obovate to subglobose; corolla-lobes oblong-elliptic to subglobose, margins erose, appendages lanceolate, acute at apex, crenulate; staminodia broadly ovate, obtuse to rounded at apex, margins erose; ovary narrowly ovoid, gradually contracted into an elongated style; fruit oblong-ellipsoid, 10–14 mm. long, often tipped by a persistent style; seed oblong-obovoid, 10–12 mm. long, apex tuberculate, variegated.

Distribution: dry, sandy soil along sea-coast, South Carolina to Florida.

Specimens examined:

CAROLINA: precise data lacking, *Walter s.n.* (G, fragment of type of *Sideroxylon sericeum*).

SOUTH CAROLINA: BEAUFORT Co.: Bluffton, 1871–99, *Mellichamp* (A, G, M); St. Helena Isl., *Harbison 10* (A). CHARLESTON Co.: Sullivan Isl., *Ravenel* (G).

GEORGIA: CHATHAM Co.: near Savannah, *Beyrich* (P). GLYNN Co.: Brunswick, *Harbi-*

son 4, 5, 1222 (A). LIBERTY Co.: Colonels Isl., *Harbison 26* (A); St. Catherines Isl., *Harbison 9, 10* (A). MCINTOSH Co.: *Harbison 2, 3, 4* (A).

FLORIDA: exact locality unknown, *Rugel 320* (M). BREVARD Co.: along Indian R., Tropic, Merritts Isl., *N. Y. State College of Forestry, Proj. I, 8334*, coll. by Rhoads (A). CLAY Co.: Magnolia Springs, *Harbison 7051a* (A). DUVAL Co.: *Fredholm 5345* (G); near Jacksonville, *Curtiss 1762*, in part, *4362, 5678* (M). LAKE Co.: Eustis, *Nash 1662* (A, P). ST. JOHNS Co.: near Matanzas, *Harbison 6* (A). VOLUSIA Co.: Seabreeze, *Webber 467* (M).

B. tenax is a coastal species characterized by dense, tawny sericeous pubescence.

6. **Bumelia anomala** (Sarg.) Clark, comb. nov.

Bumelia lanuginosa var. *anomala* Sarg. in Jour. Arn. Arb. **2**: 169. 1922.

Small tree; branches glabrous, armed with occasional stout spines, bark yellowish-gray; leaves coriaceous, oblong-obovate to broadly elliptic, 1.5–6.5 cm. long, 1–3 cm. broad, rounded to obtuse at apex, obtuse at base, lower surface densely covered with lustrous, appressed, silvery pubescence, margins slightly revolute; petioles 2–6 mm. long; inflorescence few-flowered; pedicels 3–5 mm. long, slightly enlarged toward apex; sepals oblong-elliptic to subglobose, rounded at apex; corolla-lobes oblong-elliptic to subglobose, rounded at base and apex, erose, appendages linear-lanceolate, crenulate; staminodia broadly ovate, obtuse at apex, crenulate; ovary broadly ovoid, abruptly contracted into an elongated style; fruit not observed.

Distribution: in sandy or rocky upland woods, Gainesville and Orlando, Florida.

Specimens examined:

FLORIDA: ALACHUA Co.: Gainesville: June 17, 1917, *Harbison 47* (A, TYPE), *61, 64, 97* (A). ORANGE Co.: near Orlando, *Harbison 51* (A).

A close examination of this entity reveals that it is not an anomalous form of *B. lanuginosa,* but rather a distinct species, perhaps more closely related to *B. tenax.* It is distinguished from *B. tenax* by its broad leaves and silvery pubescence. In shape of leaf it resembles *B. rufa,* but its pubescence is not at all reddish.

7. **Bumelia rufa** Raf. New Fl. N. Am. 3: 29. 1836; Aut. Bot. 2: 74. 1840.

Bumelia ferruginea Nutt. Sylva **3**: 34. 1849.

Branchlets, petioles, lower surface of leaves and inflorescence densely covered with a tawny pubescence; leaves elliptic, about 5 cm. long, about 3 cm. broad, obtuse or acutish at apex, obtuse or

rounded at base; flowers glomerate or in many-flowered fascicles; pedicels stout, 3.5 mm. long; sepals reniform to oblong-elliptic, rounded at apex; corolla-tube short, lobes suborbicular, truncate at base, appendages lanceolate, acute at apex; staminodia broadly obovate, obtuse at apex; ovary ovoid, gradually contracted into a stout style; fruit not observed.

Distribution: western Florida.

Specimen examined:
FLORIDA: "W. Fla.", *Ware* (P, TYPE).

Although it is not unlikely that the type specimen represents a teratological form of the *B. lanuginosa* complex, convincing evidence for this supposition has not been found. It therefore seems advisable to maintain this species, pending further collections in "W. Fla."

8. **Bumelia lycioides** (L) Pers. Syn. **1**: 237. 1805; Gaertn. f. in Gaertn. Fruct. & Sem. **3**[1]: 127, *pl. 202, fig. 3.* 1805; DC. Prodr. **8**: 189. 1844; Nutt. Sylva **3**: 31, *pl. 91.* 1849; Small in Bull. N. Y. Bot. Gard. **1**: 444. 1900.

Sideroxilon spinosum Duham. Arb. **2**:260, *pl. 68.* 1755.
Sideroxylon lycioides L. Sp. Pl., ed. 2, 279. 1762.
Sideroxylon decandrum L. Mant. 48. 1767.
Sideroxylon laeve Walt. Fl. Car. 100. 1788.
Lyciodes spinosum O. Ktz. Rev. Gen. **2**: 406. 1891.

Shrub or small tree, 1–8 m. high; branches clothed in gray bark and armed occasionally with short spines; leaves oblong-elliptic to oblong-obovate, 3.5–13 cm. long, 1.5–5 cm. broad, obtuse to acuminate at apex, pale green and prominently reticulate on both surfaces; petioles 5–15 mm. long; flowers numerous; pedicels 2–12 mm. long; perianth scarious, glabrous; sepals and corolla-lobes oblong-elliptic, appendages lanceolate to ovate-lanceolate; staminodia oblong-ovate, obtuse at apex; ovary subglobose, rather abruptly contracted into an elongated style; fruit obovoid to oblong-obovoid, 8–10 mm. long; seed obovoid, 6–8 mm. long.

Distribution: in moist situations, southeastern Virginia to northern Florida, westward to southern Illinois and Louisiana.

Specimens examined: the TYPE specimen, without exact locality and date of collection, is preserved in the Herbarium of the Linnean Society, London (G, photograph).
VIRGINIA: ISLE OF WIGHT CO.: near Smithfield, Oct. 1933, *Stott* (US).
CAROLINA: precise data lacking, *Walter s.n.* (G, fragment of type of *Sideroxylon laeve).*
NORTH CAROLINA: Churchs Isl., *McAtee 1812* (US). NEW HANOVER CO.: Wrightsville,

Williamson 111 (P); near Wrightsville Beach, Wilmington, *Harbison 34* (A). ROWAN Co.: near Salisbury, *Biltmore Hb. 1689c* (A).

SOUTH CAROLINA: ABBEVILLE Co.: Calhoun Falls, *Harbison 36* (A). BEAUFORT Co.: Bluffton, *Mellichamp* (A). HORRY Co.: Little R. Inlet, *Harris C19598* (US).

GEORGIA: exact locality unknown, *Boykin* (G, M). CAMDEN Co.: St. Marys R., *Harris C21149A* (US). CATOOSA Co.: near Ringgold, Aug. 10, 1895, *Small* (A, US). RICHMOND Co.: Augusta, *Harbison 10* (A). STEWART Co.: along Chattahoochee R., *Harper 1100* (G, M). WALKER Co.: summit of Bluebird Gap, Pigeon Mt., *Harper 365* (NY).

FLORIDA: near Mosquito Inlet, *Curtiss 1761*, in part (M). GADSDEN Co.: River Junction, *Harbison 140* (A). JACKSON Co.: Aspa R., near Aspalaga, July 1843, *Rugel* (M). JEFFERSON Co: near L. Miccosukee, *Palmer 38459* (A). LAKE Co.: Wekiwa Springs, Aug. 12, 1929, *O'Neill* (US).

ALABAMA: exact locality unknown, *Drake* (G), *Buckley 19* (P). DALLAS Co.: Alabama R., Selma, *Harbison 94* (A). ETOWAH Co.: n. of Attalla, July 9, 1898, *Eggert* (M). JACKSON Co.: Scottsboro, June 30, 1899, *Earle* (NY). JEFFERSON Co.: Powderly, *Palmer 35353* (A, M); along Little Cohaba Cr., *Palmer 38935* (A, M). MARENGO Co.: near Demopolis, *Palmer 27205* (A, M). WILCOX Co.: June 1841, *Buckley* (G, M, US).

MISSISSIPPI: CLARK Co.: Enterprise, *Tracy 3289* (NY). HINDS Co.: s. of Jackson, *Harbison 95* (A). MARION Co.: Columbia, Oct. 28, 1894, *Mohr* (US).

TENNESSEE: DAVIDSON Co.: near Nashville, *Biltmore Hb. 1689b* (A, G, M). DYER Co.: Dyersburg, *Palmer 17263* (A, G, M). FRANKLIN Co.: Cumberland Mt., Cowan, July 21, 1897, *Eggert* (M). MONTGOMERY Co.: bluffs of Cumberland R., Clarksville, *Palmer 17579* (A, M). RUTHERFORD Co.: near Murfreesboro, *Palmer 35496* (A, M).

KENTUCKY: exact locality unknown, 1842, *Short* (G, M, Tu). BALLARD Co.: near Swan Pond, *McFarland, Shacklette & Plymale 43* (M). LOGAN Co.: Russellville, *Palmer 17749* (A, M). LYON Co.: Eddyville, *Palmer 17863, 22506, 23703* (A, M); near Star Lime Works, *Shacklette 440-b* (G). MUHLENBERG Co.: Central City, *Palmer 17731* (A, G, M). WARREN Co.: Jenning's Cr., Bowling Green, May-Aug. 1895, *Price* (A M),

ILLINOIS: ALEXANDER Co.: Cairo, *Palmer 14930* (A). HARDIN Co.: Cave-in Rock, *Palmer 15473* (A, M). POPE Co.: near Ohio R., Golconda, *Palmer 15376, 23776* (A, M). PULASKI Co.: Mound City: June 1861, *Vasey* (G, M), *Palmer 15078, 16583* (A, M).

LOUISIANA: W. FELICIANA Parish: Wakefield, June 1907, *Cocks* (A).

Though infrequently collected, *B. lycioides* is a variable and widespread species. Like *B. Smallii*, it grows near water-courses.

8a. Bumelia lycioides var. **virginiana** Fernald in Rhodora **38**: 439. 1936; Sarg. Silva **5**: *pl. 248.* 1893.

Shrub or small tree to height of 3 m.; leaves 1.5–13.5 cm. long, 1–3.5 cm. broad generally rounded at apex, bright to pale green; petioles stout, 2–12 mm. long; inflorescence rather few-flowered; pedicels 3–9 mm. long; fruit obovoid; seed pale.

Distribution: dry wooded slopes and margins of streams, southeastern Virginia to Georgia; also southern Indiana.

Specimens examined:

VIRGINIA: ELIZABETH CITY Co.: Ft. Monroe, May 30, 1878, *Chickering* (A). NORFOLK Co.: Sewell's Pt., June 28, 1872, *Curtiss* (G, M). PRINCE GEORGE Co.: near James R., Upper Brandon, *Fernald & Long 9393* (G); Carter's Cr., York R., *Grimes 4269* (G, NY). PRINCESS ANNE Co.: near Third St. bridge, Great Neck: *Fernald & Griscom 4492* (G),

Fernald, Griscom & Long 4688 (G), *Fernald & Long 4987* (G, TYPE, M); Little Neck, *Fernald & Long 4988* (G, M).

NORTH CAROLINA: NEW HANOVER Co.: near Wrightsville, *Biltmore Hb. 1689a* (A, G, M).

SOUTH CAROLINA: BEAUFORT Co.: Bluffton, *Mellichamp* (A).

GEORGIA: FRANKLIN Co.: near Royston, *Palmer 42448* (M).

INDIANA: PERRY Co.: Ohio R. bluffs, above Cannelton, *Deam 16602* (A).

8b. **Bumelia lycioides** var. **ellipsoidalis** Clark, var. nov.[7]

Small tree, 8–10 m. high; leaves elliptic to oblong-elliptic, 5–12 cm. long, 2–4 cm. broad; petioles slender, 4–5 mm. long; inflorescence many-flowered; pedicels 4–8 mm. long, only slightly, if at all, enlarged toward apex; sepals broadly ovate; fruit ellipsoid, 10–15 mm. long, 6–8 mm. broad, black and fleshy; seed 8–10 mm. long, 4–5 mm. broad, tan.

Distribution: in open woods on loess hillsides, Tennessee, south to northern Alabama, Mississippi, and eastern Arkansas.

Specimens examined:

TENNESSEE: DAVIDSON Co.: Nashville: July-Sept. 1879, *Gattinger s.n.* (M, TYPE), July-Aug. 1879, *Gattinger* (A), *Curtiss 1761,* in part, coll. by Gattinger (G, M), Oct. 20, 1887, *Gattinger* (A, M).

ALABAMA: CALHOUN Co.: Tarsus, *Cocks* (A). FRANKLIN Co.: Russellville, Sept. 1893, *Mohr* (A).

MISSISSIPPI: OKTIBBEHA Co.: Agricultural College, *Pollard 1336* (G, M); Starkville, *Tracy 2009* (A).

ARKANSAS: PHILLIPS Co.: Crowley's Ridge near Helena, *Palmer 26649* (A, M).

This variety is characterized by its ellipsoid fruit and its limited distribution.

9. **Bumelia Smallii** Clark, nom. nov.

Bumelia lucida Small in Bull. N. Y. Bot. Gard. **1**: 443. 1900; Britt. N. Am. Trees, 778, *fig. 709.* 1908, non Roem. & Schult.

Glabrate shrub or small tree, 2–7 m. high; branches slender, reddish-brown, armed with short spines; leaves numerous, coriaceous, elliptic to elliptic-ovate, 2–5 cm. long, 1–2 cm. broad, acute to occasionally rounded at apex, cuneate at base, dark green and lucid above, paler and dull beneath, reticulate on both surfaces; petioles slender, 3–8 mm. long; flowers rather numerous; pedicels glabrous, slender, 3–7 mm. long; perianth scarious; sepals oblong-elliptic to suborbicular; corolla-lobes oblong-elliptic, appendages ovate-lanceolate, acute at apex, erose; staminodia broadly ovate, obtuse at apex; ovary ovoid; fruit subglobose, 7–10 mm. in diameter, dark

[7] **Bumelia lycioides** var. **ellipsoidalis** a specie fructu ellipsoideo differt.

bluish-black; seed subglobose, 6–9 mm. in diameter, variegated pale tan and brown.

Distribution: in low wet woods, southeastern Missouri, south to Louisiana and eastern coastal Texas.

Specimens examined:

MISSOURI: BUTLER Co.: Neelyville: *Bush 6866* (M), *Sargent 6866* (A). NEW MADRID Co.: Oct. 18, 1856, *Swallow* (M).

ARKANSAS: BRADLEY Co.: Warren, *Demaree 18967* (M). CLAY Co.: Corning, *Demaree 4235* (M). CRAIGHEAD Co.: bottoms of St. Francis R., Bono, *Demaree 3532* (M). CRITTENDEN Co.: Turrell, *Demaree 3728* (M). HEMPSTEAD Co.: along Yellow Cr., near McNab, *Palmer 26725* (A, M). JACKSON Co.: near Newport, *Palmer 35532* (A, M).

LOUISIANA: exact station lacking: *Riddell* (NY), *Featherman 95* (NY), 1836, *Hale* (G, M), no date, *Hale* (NY). ARCADIA Parish: Esterwood, *Brown 6287* (L). E. BATON ROUGE Parish: Baton Rouge, Apr. 3, 1899, *Anders* (L). FELICIANA Parish: 1838, *Carpenter 19* (NY, TYPE). ORLEANS Parish: New Orleans: *Drummond 207*, in part (G), near L. Ponchartrain, May 1838, *Riddell* (US), Apr. 16, 1846, *Fendler* (M); Audubon Pk., Oct. 6, 1936, Apr. 5, 1937, *Penfound* (Tu). OUACHITA Parish: Monroe, *Brown 6041* (L). PLAQUEMINES Parish: English Turn on Mississippi R., Sept. 1879, *Langlois* (NY). RAPIDES Parish: Alexandria, *Ball 528* (G, M). ST. LANDRY Parish: Opelousas, 1880–83, *Letterman* (M). ST. MARTIN Parish: near St. Martinsville, Oct. 16, 1893, *Langlois* (US), *45* (M). TERREBONNE Parish: n. of Houma, Oct. 28, 1912, May 22, 1913, *Wurzlow* (NY). W. CARROLL Parish: Oak Grove, *Copes* (L).

TEXAS: BRAZORIA Co.: Columbia: *Bush 141, 945* (M), Brazos R., *Palmer 5067, 6690* (M). CHAMBERS Co.: White's Ranch, *Tharp 3218* (UT). JEFFERSON Co.: Beaumont, *Palmer 12722, 13084* (A, M).

The specific designation of this plant, being preoccupied by Roemer and Schultes' binomial, must be changed. I therefore take pleasure in dedicating this species to the late Dr. John K. Small.

B. Smallii is the complement of *B. lycioides,* inhabiting for the most part the river banks west of the Mississippi River. Its leaves are consistently smaller than in *B. lycioides,* are smooth and shiny, and the pedicels are gracefully cuneate. The fruit is more or less globose.

10. **Bumelia reclinata** (Michx.) Vent. Choix des Plantes, *pl. 22.* 1803; DC. Prodr. **8**: 190. 1844; Small in Bull. N. Y. Bot. Gard. **1**: 441. 1900, non Chapm. nec Torr.

Sideroxylon reclinatum Michx. Fl. Bor. Am. **1**: 122. 1803.

Bumelia macrocarpa Nutt. Sylva **3**: 34. 1849.

Bumelia lycioides var. *reclinata* (Vent.) Gray, Syn. Fl. N. Am. **2**^{1}: 68. 1878.

Bumelia microcarpa Small in Bull. N. Y. Bot. Gard. **1**: 440. 1900.

Decumbent or ascending shrub, 1–2 m. high; branches slightly geniculate, spinescent; leaves numerous, thin, obovate-spatulate to oblanceolate, 2–7 cm. long, 0.5–4 cm. broad, rounded or retuse at

apex, cuneate at base, dark green and shiny above, paler and dull beneath, rather prominently reticulate; petioles 2–4 mm. long; inflorescence few-flowered; pedicels 3–5 mm. long, enlarged toward apex; sepals oblong-obovate to suborbicular; corolla-lobes suborbicular, slightly erose, appendages lanceolate, slightly erose; staminodia lanceolate, not plicate, slightly erose; ovary glabrous, suborbicular to ovoid, gradually contracted into a stout style; fruit subglobose, 4–6 mm. in diameter, frequently tipped by a persistent style; seed subglobose, 3–6 mm. in diameter, brown, occasionally variegated.

Distribution: in sandy soil, Georgia to Florida and Louisiana.

Specimens examined:

GEORGIA: exact place and date of collection unknown, *Michaux s.n.* (G, fragment of TYPE); complete data lacking, *Nuttall s.n.* (P, type of *B. macrocarpa).* THOMAS Co.: along Ochlockonee R., near Thomasville, May 28–June 6, 1895, *Small* (NY).

FLORIDA: exact locality unknown: *Rugel 101* (M, US), *Garber 24* (G, M). ALACHUA Co.: *Harbison 104, 108* (A); Gainesville: Mar.–June 1876, *Garber s.n.* (NY, type of *B. microcarpa*, US), *Palmer 38429* (A, NY). COLLIER Co.: Tommy Cypress, head of Chokoloskee R., *Small 7751* (NY). DADE Co.: near Homestead Rd. between Cutler and Longview Camp, *Small & Carter 1469* (NY); Homestead to Big Hammock Prairie, *Small, Carter & Small 3406* (N); Camp Jackson to Camp Longview, *Small, Carter & Small 3500* (NY); Paradise Key: *Bessey 2* (A), *Harper 110* (A), *Rehder 898* (A), Royal Palm Pk., *Fisher 54* (US); Camp Jackson, *Britton 218, 219* (NY); Nixon-Lewis Hammock, *Small & Mosier 6400* (NY). DIXIE Co.: near Cross City, *Palmer 27301* (A). FRANKLIN Co.: Chattahoochee, 1896, *Chapman* (M). GADSDEN Co.: River Junction, *Harbison 119, 123* (A). HIGHLANDS Co.: Kissimmee Prairie, e. of L. Istokpoga, *Small, Mosier & DeWinkeler 10897* (NY, US). HILLSBOROUGH Co.: Tampa, June–July 1898, *Ferguson* (M). JACKSON Co.: near Grand Ridge, *Palmer 35266* (A, M, NY); Marianna, *Harbison 2, 28* (A). LAKE Co.: Eustis, *Nash 1261* (G, NY). LEE Co.: n. of Bonita Springs, *Seibert 1386* (M); Estero, Jan. 28, 1920, *Ames* (A); Ft. Myers: *Standley 154* (A, G, M, NY), *Hitchcock 199* (G, M, NY); Samville, June 6, 1912, *Harshberger* (NY). LEON Co.: s. of Tallahassee, *Palmer 38484* (A). MANATEE Co.: Manatee, June 1878, *Garber* (G). MONROE Co.: Long Key: *Small & Wilson 1852* (NY, US), *Small & Carter 2912, 2986, 2987, 2988, 2988a* (NY); Flamingo, Cape Sable Region, *Small, Small & DeWinkeler 11537* (G, NY, US). OKEECHOBEE Co.: Okeechobee Prairie, e. of Ft. Bassinger, *Small, Mosier & DeWinkeler 10944* (G, M, NY). OSCEOLA Co.: *Fredholm 5832* (G, NY). SARASOTA Co.: s. of Venice, *Seibert 1392* (M). SUWANNEE Co.: banks of Suwannee R., Branford, *Curtiss 6656* (A, G, M, NY). TAYLOR Co.: near Hampton Springs, *Palmer 38471* (A, M, NY); Perry, *Harbison 3* (A). VOLUSIA Co.: near Mosquito Inlet, *Curtiss 1761*, in part (A, G, M, NY); near Seville, *Curtiss 6690* (A, G, M, NY); edge of causeway, n. of St. Johns R. bridge, *Baker 516* (A). WAKULLA Co.: St. Marks, *Harbison 1503* (A).

LOUISIANA: exact locality unknown, *Hale* (G, NY).

11. **Bumelia cassinifolia** Small in Bull. N. Y. Bot. Gard. 1: 442. 1900; Britt. N. Am. Trees, 778, *fig. 708.* 1908.

Glabrous shrub or small tree, 5–10 m. high; branches slender, frequently armed with short, stout spines, clothed in reddish-brown

bark; leaves thinnish, oblong-obovate, 2.5–10 cm. long, 1–4.5 cm. broad, acute to rounded at apex, cuneate at base, margins slightly revolute, dark green and reticulate above, paler and puberulent beneath with midvein and secondary nerves prominent; petioles slender, 6–8 mm. long; inflorescence few-flowered, glabrous; pedicels slender, 4–11 mm. long, slightly enlarged toward apex; sepals and corolla-lobes suborbicular, appendages lanceolate or ovate-lanceolate, obtuse to acuminate at apex, erose; staminodia broadly lanceolate or ovate, obtuse at apex; ovary ovoid, gradually contracted into an elongated style; fruit subglobose, 8–12 mm. in diameter; seed subglobose to broadly ovoid, 6–10 mm. long.

Distribution: in moist, sandy soil, southwestern Georgia to Louisiana.

Specimens examined:

GEORGIA: DECATUR Co.: along Flint R., near Bainbridge, *Harbison 1357, 1358* (A).

FLORIDA: JACKSON Co.: n. of Marianna, *Wiegand & Manning 2487* (G).

LOUISIANA: ST. LANDRY Parish: alt. 60 ft., Opelousas, May.–Aug. 11, 1883, *Letterman 287* (NY, TYPE).

B. cassinifolia is a rare plant having the foliage characters of a very vigorous *B. reclinata* and the fruiting characters of *B. Smallii.* It may possibly prove to be of hybrid origin.

12. **Bumelia texana** Buckl. in Bull. Torr. Bot. Club **10**: 91. 1883, as *Texana;* Small in Bull. N. Y. Bot. Gard. **1**: 443. 1900.

Bumelia reclinata Torr. Bot. Mex. Bound. Surv. 109. 1859, *pro parte,* non Vent. nec Chapm.

Bumelia monticola Buckl. in Bull. Torr. Bot. Club **10**: 91. 1883; Sarg. Man., ed. 2, 814, *fig. 725.* 1922.

Armed shrub or small tree, 1–7 m. high, with reddish-brown bark; lower surface of leaves, petioles, and inflorescence glabrescent; leaves coriaceous, generally obovate-spatulate, 1–7 cm. long, 0.5–3 cm. broad, rounded to retuse or even apiculate at apex, often slightly revolute, obtuse to cuneate at base, prominently reticulate and pale green on both surfaces; petioles slender, 3–10 mm. long; inflorescence few-flowered; pedicels 1-6 mm. long, enlarged toward apex; sepals subreniform to suborbicular; corolla-lobes oblong-elliptic, appendages ovate-lanceolate; staminodia ovate-lanceolate, obtuse to rounded at apex; ovary subglobose, abruptly contracted into an elongated style; fruit obovoid, 8–10 mm. long, often tipped by a persistent style; seed oblong-ellipsoid, 6–8 mm. long, variegated, red-brown and tan.

Distribution: in dry limestone soil, Arbuckle Mountains in Oklahoma, and west-central Texas.

Specimens examined:

OKLAHOMA: MURRAY Co.: Arbuckle Mts., *Clark & Williams 510* (M).

TEXAS: mountains near lower crossing of Pecos R., W. Tex., 1875, *Buckley* (NY, TYPE); "W. Tex.–N. Mex.", *Wright 422* (G, NY, US); Live Oak Cr.: *Wright 1434* (A, G, NY), *Bigelow s. n.* (NY, type of *B. reclinata* Torr.). BEXAR Co.: *Jermy 83* (NY), *117* (M); Leon Springs, *Clemens & Clemens 891, 893* (M); Blanco Rd. at Cibolo Cr. crossing, n. of San Antonio, *Metz 419* (NY). BLANCO Co.: Blanco: *Reverchon 1555* (A, M, US), *Cory 15629* (A). BREWSTER Co.: Dog Gap, Santiago Mts.: Apr. 14, 1936, *Cory* (A), *Parks & Cory 18702* (Tr.). BROWN Co.: near Brownwood, *Palmer 29539, 29567* (A). BURNET Co.: Burnet, *Palmer 10257* (A, M). CALLAHAN Co.: Baird, *Palmer 13678, 13679* (A, M). COLEMAN Co.: Santa Anna, *Palmer 10386* (A, M). COKE Co.: Bronte, *Palmer 10355* (A, M). COMAL Co.: New Braunfels, *Lindheimer 199* (M); "Devil's Backbone," *Palmer 12187, 12207* (A); Fischer's Store, *Palmer 12208, 12208a* (A). CONCHO Co.: n.w. of Paint Rock: *Cory 9761, 9763* (A), *Parks & Cory 9762* (Tr). CROCKETT Co.: *Reverchon 97* (G). EDWARDS Co.: *Palmer 10975* (A). EL PASO Co.: mountains, 1875, *Buckley s.n.* (NY, type of *B. monticola*). GILLESPIE Co.: Bear Mt.: *Cory 12925, 12926* (A), *Parks & Cory 12926* (Tr); Fredericksburg, *Palmer 10057* (A, M). HARDIN Co.: s. of Silsbee, *Cory 11278, 11279* (A). HOWARD Co.: Big Spring, *Palmer 12483, 13066* (A, M). IRION Co.: Mertzon, *Palmer 12426* (A, M). KENDALL Co.: Boerne, *Palmer 9840, 10818, 11599, 12270, 13637, 13648* (A, M); Spanish Pass, *Cory 19343* (A). KERR Co.: Kerrville: *Heller 1938* (NY, US), *Mackenson 5* (A), *Palmer 9937, 12210* (A, M); Lacey's Ranch, *Palmer 10007, 11226, 12229a* (A). KIMBLE Co.: Junction, *Palmer 10913* (A, M). MENARD Co.: Menard, *Palmer 11888, 11899* (A). MITCHELL Co.: Colorado: June 9, 1900, *Eggert* (M), *Palmer 13787* (A, M). NOLAN Co.: Sweetwater: Palmer *12431, 13051, 14522, 14523, 33973* (A, M), Aug. 3, 1934, *Barkley* (M, UO). PALO PINTO Co.: Strawn, *Palmer 14246* (A, M, US). PECOS Co.: near Sheffield, *Ferris & Duncan 2919* (M). REAL Co.: Barksdale, *Palmer 13525* (A, M); Leaky, *Palmer 10148* (A, M). SAN SABA Co.: San Saba, *Palmer 11810* (A, M). SUTTON Co.: head of Llano R., between Sonora and Sawyer Spring, *Eggleston 16729* (NY); s.e. of Sonora: *Cory 15315* (A), *Parks & Cory 15314* (Tr). TERRELL Co.: near Sanderson, *Palmer 33442* (A). TOM GREEN Co.: banks of Concho R., San Angelo: *Reverchon 3868* (M), *Palmer 10322, 10360* (M). UVALDE Co.: bluffs of Frio R., Concan, *Palmer 10203, 11545* (A, M); Uvalde, *Palmer 11321, 11347* (A); Leona R., *Parks & Cory 23871* (Tr). VALVERDE Co.: Comstock, *Palmer 11063* (A); near Shumla, *Palmer 33489* (A, M, NY).

A glabrous or glabrescent shrub or small tree, *B. texana* has leaves which vary from long and spatulate to short and obovate. There may possibly be two elements here; nevertheless *B. texana* and *B. monticola* are conspecific.

13. **Bumelia megacocca** Small in Bull. N. Y. Bot. Gard. **1**: 441. 1900, as *megococca*.

Evergreen, glabrous, thorny shrub with spreading or procumbent branches and with pale bark in angular, corky ridges broken by numerous lenticels; leaves coriaceous, obovate or oblong-oblanceolate, 1–3.5 cm. long, 0.5–1.2 cm. broad, rounded or retuse at apex, deep green and somewhat shiny above, paler and prominent-

ly reticulate beneath, slightly revolute, short-petiolate; pedicels stout, 1–3 mm. long; flowers not observed; fruit subglobose, 10–13 mm. in diameter, black; seed 9–10 mm. in diameter, pale, smooth and shiny, variegated.

Distribution: in sandy soil, Florida.

Specimen examined:

FLORIDA: HILLSBOROUGH Co.: Tampa, Oct. 1877, *Garber s.n.* (NY, fragment of TYPE).

The only available material is a fragmentary fruiting specimen which seems to be a *Bumelia.*

14. **Bumelia angustifolia** Nutt. Sylva 3: 38, *pl. 93.* 1849; Sarg. Silva 5: 175, *pl. 249.* 1893; Small in Bull. N. Y. Bot. Gard. 1: 439. 1900.

Bumelia reclinata Torr. Bot. Mex. Bound. Surv. 109. 1859, *pro parte,* non Vent. nec Chapm.

Bumelia cuneata Gray, Syn. Fl. N. Am. 2^1: 68. 1878, non Sw.

Lyciodes angustifolium O. Ktz. Rev. Gen. 2: 406. 1891.

Bumelia parvifolia Chapm. Fl. Southeast. U. S., ed. 3, 295. 1897, non A. DC.

Bumelia Schottii Britt. N. Am. Trees, 777. 1908.

Glabrous shrub or small tree, 2–8 m. high; branchlets unarmed and slender or spinescent and stout; leaves numerous, variable, persistent, coriaceous, narrowly oblanceolate-spatulate to obovate, 1–1.5 cm. long, 0.5–2 cm. broad, rounded to acutish at apex, cuneate, pale green or grayish and smooth above, brighter green and obscurely reticulate beneath, margins slightly revolute; petioles 1–10 mm. long; inflorescence few- to many-flowered; pedicels 3–11 mm. long; sepals oblong-elliptic, erose, appendages ovate-lanceolate, acute at apex, erose; staminodia ovate, acute at apex, erose; ovary ovoid, gradually contracted into a slender, elongated style; fruit oblong- to ellipsoid-cylindrical, 8–10 mm. long, purplish-black, fleshy, usually tipped by a long, persistent style; seed oblong-ellipsoid, 6–8 mm. long, narrowed at base, pale.

Distribution: in sandy soil, Florida, Texas and adjacent Mexico, also in Bahama Islands.

Specimens examined:

FLORIDA: BREVARD Co.: Merritts Isl., *Harris C19999* (US). CHARLOTTE Co.: Bocagrande, Jan.–Feb. 1920, *Ames* (A). COLLIER Co.: Ten Thousand Isls., *Simpson 364* (G). DADE Co.: Planter, Key Largo, *Eaton 444* (A); lower end of Old Rhoades Key, Apr. 1911, *Simpson* (A). HILLSBOROUGH Co.: Tampa Bay: *Leavenworth* (G, NY); Paradise Key, *Maxon 10926* (US). LEE Co.: Coconut, *Moldenke 5780* (NY); Ft. Myers, *Chapman 14* (US); Marco, *Standley 12808* (US); Sanibel Isl., Apr. 10, 1886, *Sargent* (A). LEVY

Co.: Cedar Keys, *Garber 25* (G, US) MANATEE Co.: Terra Ceia Isl., *Simpson 276* (G, US). MONROE Co.: Bahia Honda Key, May 1881, *Curtiss 1765* (G, M, US); s. border of everglades, Jan. 1882, *Curtiss 1765* (A, M, US); Big Pine Key, *Seibert 1276, 1311* (M); e. of Cape Sable, Nov. 1912, *Simpson* (A); Key West: *Blodgett s.n.* (NY, part of TYPE, G), *Chapman s.n.* (NY, co-type of *B. parvifolia), Rugel 86, 87* (G), *132, 174* (NY), Nov. 28, 1886, *Sargent* (A, G), *Britton 508, 509* (NY), *Small & Small 4909* (G), *Seibert 1236* (M); Lignum-vitae Key, Apr. 1911, *Simpson* (A); Long Key, *Curtiss 503* (A); Marquesas Key, Apr. 12, 1886, *Sargent* (A); Palm Key near Flamingo, *Howell 1146* (A); Sugarloaf Key, *Pennell 9581* (M, NY); Upper Metacombe Key, Nov. 15, *Curtiss* (A).

TEXAS: Torrecillas, *Griffiths 6424* (M). ARANSAS Co.: Copano Bay, *Tharp 1550, 1664* (US, UT). ATASCOSA Co.: *Schulz 108, 482* (US); Campbelton, *Palmer 11230* (A, G). CALHOUN Co.: Indianola: *Cory 11617* (A), *Parks & Cory 11617* (Tr); Magnolia Beach, May 22, 1930, *Tharp* (UT). CAMERON Co.: Brownsville: *Hanson 451* (US), *Runyon 252* (M, US, UT), *Rose & Russell 24190* (A, US), *24190a* (NY); Rio Hondo, *Chandler 7088* (G, M, NY); Santa Maria, May 13, 1889, *Tucker* (A, US). DIMMIT Co.: El Jardin, *Small & Wherry 11889* (NY). FRIO Co.: Dilley, Dec. 16, 1932, *Parks* (Tr). HIDALGO Co.: n.w. of Edinburg, *Clover 1599* (UT); La Joya, Mar. 2, 1940, *Parks* (Tr); near Mission: *Hanson 336* (G, M, NY, US, UT), *Clover 181* (M), *Walker 17819* (Tr); Tabasco, *Clover 1372* (A). JACKSON Co.: E. Karankawa Pt., *Tharp 1419* (UT). LA SALLE Co.: near Encinal, May 1, 1882, *Buckley* (A); near Nueces, Aug. 1881, *Buckley* (A, NY), Oct. 1881, *Buckley* (US). MATAGORDA Co.: w. of gulf: *Cory 11555* (A), *Parks & Cory 11555* (Tr). NUECES Co.: n.w. of Corpus Christi, *Cory 17076* (A); Osa Bay: *Cory 20566* (A), *Parks & Cory 20565* (Tr). STARR Co.: s. of Hebbronville, *Tharp 5936* (UT); near Rio Grande City, Sept. 10–11, 1929, *Tharp* (UT). WEBB Co.: near Laredo: *Rose 18047* (NY, US), Apr. 12, 1936, *Penfound* (Tu), June 1853, *Schott 69½* (NY, type of *B. Schottii)*; s. of Milo: *Cory 16901* (A), *Parks & Cory 16900* (Tr).

MEXICO: NUEVO LEON: near Monterrey, *Pringle 2787* (A).

BAHAMA ISLANDS: Hog Isl., New Providence, *Wilson 8317* (M).

A distinct, though variable species, *B. angustifolia* is easily recognized by its entirely glabrous foliage.

DOUBTFUL AND EXCLUDED SPECIES

Bumelia ambigua Ten. Sem. Hort. Neap. 1827.

Bumelia confertiflora Nutt. in Fras. Cat. No. 12. 1813, *nomen nudum.*

Bumelia denticulata Raf. New Fl. N. Am. 3: 29. 1836. Rafinesque later stated, in Aut. Bot. 2: 74. 1840, that this is "certainly no *Bumelia.*"

Bumelia lucida Roem. & Schult. Syst. **4**: 499. 1819 = SIDEROXYLON LUCIDUM Soland. ex Lam., fide DC. Prodr. **8**: 194. 1844.

Bumelia pubescens Ten. Sem. Hort. Neap. 1827.

Bumelia serrata Pursh, Fl. Am. Sept. **1**: 155. 1814 = PRUNUS CAROLINIANA Ait., fide Nutt. Gen. **1**: 136. 1818; S. Wats. Bibl. Ind. N. Am. Bot. 304. 1878.

Bumelia serrulata Raf. New Fl. N. Am. 3: 29. 1836.

Bumelia syderoxyloides Hort. ex Lavallée, Arb. Segrez. 160. 1877, *nomen nudum.*

Bumelia undulata Raf. New Fl. N. Am. 3: 28. 1836.

List of Collectors and Exsiccatae

Collector's numbers are printed in *italics;* or, when specimens are not numbered, they are indicated by a dash. Numerals in parentheses represent numbers assigned to species in this revision.

Ames, J. S. — (10); —, —, —, — (14).
Anders, W. H., Jr. — (9).
Andrews, D. M. *20* (1b).

Baker, C. H. *504, 505, 506, 507, 508, 509, 510, 511a,b,c, 512a,b,c, 513, 514, 515, 525, 544* (3); *503* (4); *516* (10).
Ball, C. R. *528* (9).
Barkley, F. A. — (12).
Bartram, E. B. *2425* (1b).
Beck, L. C. — (1).
Bessey, E. A. *2* (10).
Beyrich, C. — (1b); — (5).
Bigelow, J. M. *678* (1b); — (12).
Biltmore Hb. *1688* (1); *1689b,c* (8); *1689a* (8a).
Black, W. C. *757* (1b).
Blodgett, J. L. — (14).
Blumer, J. C. *2298* (2).
Bogue, E. E. — (1b).
Boon, E. —, — (1b).
Boykin, S. — (8).
Braner, W. N. — (1b).
Brigham, J. *11* (1b).
Britton, N. L. *218, 219* (10); *508, 509* (14).
Brown, C. A. *6869, 6872* (1b); *6041, 6287* (9).
Buckley, S. B. —, —, — (1a); — (2); —(3); *19*, — (8); —, — (12); —, —, — (14).
Bull, R. *248* (1b).
Bush, B. F. *1, 2, 3, 210, 226, 802, 877, 1427, 1524* (1a); *171, 182, 236, 262, 491, 704, 905, 956, 1138, 1619, 3130, 4978, 9266, 10148, 10390, 10390a, 13470, 13596, 13628, 13654, 13691, 13893* (1b); *141, 945, 6866* (9).

Cabell, P. H. — (1).
Carpenter, W. M. *19* (9).
Chandler, H. P. *7088* (14).
Chapman, A. W. — (1); — (10); *14*, — (14).
Chickering, J. W., Jr. — (8a).
Clark, R. B. & H. B. Parks. *567, 574* (1a).
—— & J. W. Williams. *510* (12).
Clemens, Mr. & Mrs. J. *889* (2); *891, 893* (12).
Clover, E. U. *181, 1372, 1599* (14).
Cocks, R. S. — (1); — (1b); — (8); — (8b).
Copes, Mrs. H., Jr. — (9).
Cory, V. L. *5770, 11618* (1a); *13227, 13369* (1b); *9761, 9763, 11278, 11279, 12925, 12926, 15315, 15629, 19343*, — (12); *11555, 11617, 16901, 17076, 20566* (14).
Cutler, H. C. *858* (1a).
Curtiss, A. H. *35, 1762*, in part (1); *1762'* (3); *1764*, — (4); *1762*, in part, *4362, 5678* (5); *1761*, in part (8); — (8a); *1761*, in part (8b); *1761*, in part, *6656, 6690* (10); *503, 1765, 1765*, — (14).

Deam, C. C. *16602* (8a).
Demaree, D. *99, 4563, 4614, 5294, 8496, 8716, 9561, 10017, 13180, 16100, 19281* (1b); *3532, 3728, 4235, 18967* (9).
Demetrio, C. H. *47* (1b).
Dickson, D. — (1b).
Dixon, R. A. *403* (1a).
Drake, D. — (8).
Drummond, T. *207*, in part (1b); *207*, in part (9).

Earle, F. S. — (8).
Eastwood, A. *8164* (2).
Eaton, A. A. *444* (14).
Eggert, H. —, — (1a); —, —, —, —, —, — (1b); —, — (8); — (12).
Eggleston, W. W. *16729* (12).
Emig, W. H. *658* (1b).
Engelmann, G. *53*, — (1b).

14610, 14660, 14664, 15723, 18055, 18318, 18483, 19390, 20472, 20556, 20826, 20884, 21160, 21244, 21982, 22030, 22072, 22107, 22642, 22730, 22860, 22929, 23015, 23083, 23366, 24165, 24314, 24601, 24749, 25339, 26136, 26316, 26565, 26980, 28931, 29075, 30067, 30148, 30172, 31622, 31639, 32819, 34761, 35533, 35553, 35595, 35646, 35956, 35983, 36769, 39220, 39227, 39231, 39504, 41809, 41927 (1b); *11367* (2); *27385, 27438, 38350, 38366* (3); *14930, 15078, 15376, 15473, 16583, 17263, 17579, 17731, 17749, 17863, 22506, 23703, 23776, 27205, 35353, 35496, 38459, 38935* (8); *42448* (8a); *26649* (8b); *5067, 6690, 12722, 13084, 26725, 35532* (9); *27301, 35266, 38429, 38471, 38484* (10); *9840, 9937, 10007, 10057, 10148, 10203, 10257, 10322, 10355, 10360, 10386, 10818, 10913, 10975, 11063, 11226, 11321, 11347, 11545, 11599, 11810, 11888, 11899, 12187, 12207, 12208, 12208a, 12210, 12229a, 12270, 12426, 12431, 12483, 13051, 13066, 13525, 13637, 13648, 13678, 13679, 13787, 14246, 14522, 14523, 29539, 29567, 33442, 33489, 33973* (12); *11230* (14).

—— & J. A. Steyermark. *41399* (1b).

Palmer, Edw. *156, 232* (2); *326* (3).

Parker, C. M. *4791* (1a).

Parks, H. B. — (1a); —, — (14).

—— & V. L. Cory. *7791* (1a); *13368* (1b); *6271* (2); *9762, 12926, 15314, 18702, 23871* (12); *11555, 11617, 16900, 20565* (14).

Peebles, R. H. *11698* (2).

——, G. J. Harrison & T. H. Kearney. *388* (2).

Penfound, W. T. — (1); — (9); — (14).

Pennell, F. W. *9581* (14).

Pollard, C. L. *1336* (8b).

Price, S. F. — (8).

Pringle, C. G. — (2); *2787* (14).

Ravenel, H. W. — (5).

Rehder, A. *898* (10).

Reverchon, J. *384, 590, 3194, 3867,* —, — (1a); —, — (1b); *97, 1555, 3868* (12).

Riddell, J. L. —, — (9).

Rolfs, P. H. *46* (3).

Rose, J. N. *18047* (14).

—— & P. G. Russell. *24190, 24190a* (14).

Rugel, F. *161* (3); *320* (5); — (8); *101* (10); *86, 87, 132, 174* (14).

Runyon, R. *252* (14).

Ruth, A. *202* (1a).

Rydberg, P. A. & R. Imler. *317* (1b).

Sargent, C. S. —, —, —, —, — (1a); — (1b); *6866* (9); —, —, — (14).

Saurman, B. F. — (1).

Schostag, E. L. *3002* (1a).

Schott, A. *69½* (14).

Schulz, E. D. *49, 2434* (1a); *36* (2); *108, 482* (14).

Seibert, R. J. *1412, 1412a* (1); *1411* (4); *1386, 1392* (10); *1236, 1276, 1311* (14).

Shacklette, H. T. *440-b* (8).

Short, C. W. — (8).

Shreve, F. *5382* (2).

Simpson, C. T. —, —, — (14).

Simpson, J. H. *578* (3); *276, 364* (14).

Small, J. K. — (1); — (8); *7751,* — (10).

—— & J. J. Carter. *1469, 2912, 2986, 2987, 2988, 2988a* (10).

——, —— & G. K. Small. *3406, 3500* (10).

—— & J. B. DeWinkeler. *9042, 9965* (3).

—— & C. A. Mosier. *6400* (10).

——, —— & J. B. DeWinkeler. *10897, 10944* (10).

—— & E. W. Small. *4909* (14).

——, K. W. Small & J. B. DeWinkeler. *10755* (3).

——, J. W. Small & J. B. DeWinkeler. *10666* (3); *11537* (10).

—— & E. T. Wherry. *11889* (14).

—— & P. Wilson. *1852* (10).

Spears, W. L. *113* (1b).

Stacy, H. I. *107* (1b).

Standley, J. P. *154* (10).

Standley, P. C. *12808* (14).

Stevens, G. W. *1261½, 1720, 2154, 2628, 2960-E* (1b).

Steyermark, J. A. *1270, 1492, 11641, 11888, 13181, 13479, 13630, 13737, 14693, 14758, 15964, 20237, 22991, 24108, 26076* (1b).

Stott, A. G. — (8).

Sudworth, G. B. — (1a); — (2).

Swallow, G. C. — (9).

Tharp, B. C. *1424, 1431,* —, —, —, — (1a); *3218* (9); *1419, 1550, 1664, 5936,* —, — (14).

INDEX TO SPECIES

New names, varieties and combinations are printed in **bold-face** type, synonyms are in *italics*, while valid names appear in Roman type.

MONOGRAPH OF MALVAVISCUS[1]

ROBERT WALTER SCHERY
Research Assistant, Missouri Botanical Garden
Instructor in Botany in the Henry Shaw School of Botany of Washington University

Introduction

In the plant kingdom there are certain families which are quite distinctive but with very indefinite generic bounds, the Malvaceae being one such family. For example, two species have been included in *Malvaviscus* which intergrade with *Pavonia* and which would better be placed in the latter genus. The same is true in other genera of the family as Kearney[2] found to be the case in *Sphaeralcea.* And when a taxonomist comes to consider specific and subspecific delimitation within *Malvaviscus,* he finds himself in the midst of an unmanageable and indefinable maze of incipient taxonomic entities. This can be attested to by the fact that no comprehensive work has been done in the genus since its establishment almost 200 years ago.

The situation is exemplified by the *Malvaviscus arboreus* complex where there is no constant character of taxonomic value. There is tremendous variation, even with separate branches on the same plant. In Panama, within an area of a few hundred meters, plants with 2, 3, 4, or 5 calyx lobes were found; with short or long involucre lobes; with excurrent rows of hair on the stem or without hair; etc. As a result of such manifest variation, innumerable species have been described, with descriptions based on a single specimen. If this were to be the general practice there would be almost as many species of *Malvaviscus* as there are specimens, since almost every specimen collected differs from all others at least to some slight degree. Thus in a taxonomic treatment of the genus two alternatives exist: excessive splitting into innumerable indistinct and undefinable "species," or lumping into few well-marked species with varietal classification for those groups which are distinct at their extremes but do intergrade with all or most other groups.

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[1] An investigation carried out at the Missouri Botanical Garden in the Graduate Laboratory of the Henry Shaw School of Botany of Washington University and submitted as a thesis in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

[2] Kearney, T. H., in Univ. Calif. Pub. Bot. 19: 1–128, *pl. 1–12, 1 fig.* 1935.

Issued September 18, 1942.

For the conscientious taxonomist there is no middle course in this genus, for if these intergrading types are to be considered as worthy of specific rank, surely the "good" or distinct species, obviously of higher degree difference even to the most casual observer, merit generic rank. It is my opinion that the second or "lumping" alternative is the only acceptable one, both from a scientific and a practical standpoint.

History of the Genus

Being a showy and conspicuous plant, *Malvaviscus* has been recognized, under one name or another, for centuries. One of the first names under which this genus was included was *Alcea* of Plukenet. Sloane, Tournefort, Plumier, and others placed it in *Malva,* and Linnaeus in *Hibiscus.* Earlier, Hernandez suggested a close relationship with *Althaea,* but used the Aztec name "Atlat Zopillin" in his writing; however, Petiver in 1704 used *Althaea* in a polynomial description for a species of *Malvaviscus* (fide Dillenius).

In 1732 Dillenius proposed the name *Malvaviscus* as distinct from *Malva,* but still used it in a polynomial form as: "Malvaviscus arborescens, flore miniato clauso." He recognized that this new name was synonymous with *Alcea* (in part) of Plukenet, Petiver's "Althaea americana coccinea, flore clauso," and the Aztec "Atlat Zopillin."

Although Linnaeus in 1753 included *Malvaviscus* in *Hibiscus,* Adanson in 1763 and Cavanilles in 1787 accepted *Malvaviscus* as a valid genus in the binomial sense. But in 1788 Swartz proposed to rename the genus *Achania,* a name recognized only by a few authors of the early 19th century. In 1824 A. P. de Candolle divided *Malvaviscus* into two sections, one of which he called *Achania,* the other, *Anotea;* the latter was raised to generic rank by Kunth in 1846, but evidently it should be included in *Pavonia.* During the last century *Malvaviscus* has been generally recognized as a valid genus synonymous with the section *Achania* of de Candolle and doubtfully synonymous with de Candolle's other section, *Anotea.*

Previous Work on the Malvaceae

In the Malvaceae, as a whole, little recent taxonomic work has been done. Kearney[3] monographed the North American species

[3] loc. cit. 1935.

of *Sphaeralcea.* Roush[4] monographed *Sidalcea* and also published a synopsis of *Robinsonella.*[5] Earlier in the century Fries[6] presented a monographic treatment of *Wissadula* and *Pseudabutilon,* Hill[7] published on the acaulescent species of *Malvastrum,* and Hochreutiner[8] offered a monograph of *Anoda.* In 1907 Watt[9] published a book which included a revision of *Gossypium,* and in 1900 appeared Hochreutiner's revision of *Hibiscus.*[10]

However, previous to the turn of the century, monographic treatment of genera in the Malvaceae seems scarcely to have been attempted, although numerous non-monographic publications had appeared, some of first-rank importance. Cavanilles published on *Sida;* Garcke on *Pavonia, Abutilon, Malvastrum,* etc.; Schumann and Gürcke on Malvaceae in Martius' 'Flora Brasiliensis' and elsewhere; E. G. Baker on a synopsis of the Malveae; Bentham on a key to the Malvaceae and Sterculiaceae; Gray and Robinson on Malvaceae of North America. References to these and many other important systematic publications on the Malvaceae can be found in the 'Bradley Bibliography'[11] and in other bibliographies.

Non-taxonomic studies on Malvaceous genera have appeared rather frequently. Because of its economic importance, *Gossypium* has been the subject of many investigations, especially along cytogenetic and anatomical lines, and probably ten times as much literature has been published concerning this genus as all other genera of the Malvaceae combined. However, the bast fiber production in *Sida* and other genera, the virus transmission in *Abutilon,* photoperiodism and embryological development in several genera, and ecological studies involving certain Malvaceae have been the subjects of numerous recent investigations. Then too, chromosome counts have been made in almost all genera of the family and about 15 per cent of the species. Nor can we fail to notice the continuous use of certain species in horticultural work.

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[4] Roush, Eva M., in Ann. Mo. Bot. Gard. **18**: 117–244. 1931.

[5] Jour. Arnold Arb. **12**: 49–59, *7 figs.* 1931.

[6] Fries, R. E., in Kgl. Svenska Vet. Handl. **43**: 1–114, *10 pls.* 1908.

[7] Hill, H. W., in Jour. Linn. Soc. Bot. **39**: 216–230. 1909.

[8] Hochreutiner, B. P. G., in Ann. Cons. & Jard. Bot. Genève **20**: 29–68. 1916.

[9] Watt, G. The Wild and Cultivated Cotton Plants of the World. 406 pp. 1907.

[10] Ann. Cons. & Jard. Bot. Genève **4**: 23–191, *9 figs.* 1900.

[11] Rehder, A. The Bradley Bibliography. **2**[1]: 518–528. Arnold Arb. Pub. 3. 1912.

MORPHOLOGY OF MALVAVISCUS

The genus *Malvaviscus* consists of woody perennial plants that may be shrub-like or vine-like, clambering or suberect. Roots are of the tap-root type, fairly thick, often twisted and distorted. Stems are terete, woody, and, although moderately stout, are unable to support the mature plant erect; they branch freely, bear many leaves, are green and generally stellate-pubescent when young, but become glabrous or subglabrous and gray-brown with age. Branches neither twine nor possess tendrils, vine-like specimens merely clambering upon available support.

The leaves are alternate, stipulate, petiolate. The blade is moderately thick, broadly ovate-cordate to linear-lanceolate, unlobed to palmatifid, deeply serrate to subentire. The pubescence of the blade varies, consisting of stellate or straight hairs or a mixture of the two on the upper surface, of more abundant stellate hairs on the lower surface; or the blade may be glabrous in age (pl. 16, figs. 2, 3, 4). Stellate hairs may be appressed to erect, few or many-rayed, large and coarse or small and fine, or a mixture of the types may occur. Venation is prominent, reticulate, usually consisting of five larger veins with numerous anastomosing lateral veinlets. The petiole is variable in length, uniformly pubescent, with a ridge of hair (often decurrent on the stem), or glabrous. Stipules are linear-lanceolate, about 7 mm. long, caducous and usually missing in herbarium material.

The inflorescence is a few-flowered, terminal or subterminal cyme, or flowers may occur singly or in groups in the axils of leaves. Usually there is a combination of these types, the young branch being itself a leafy "inflorescence." The pedicels are relatively short, scarcely ever as long as the flower, pubescent like the petiole, and usually more or less aggregated. Flowers are small to large in the *Malvaviscus arboreus* complex (1.5–5.5 cm. long),[12] very large in *Malvaviscus candidus* (about 8 cm. long), and are generally very showy, but not fragrant. They never open fully but remain as a contorted tube, each petal overlapping the next. The mature staminal column is exserted about one third its length beyond the petals.

The involucre (pl. 17, fig. 4), often designated as subcalyx or involucel, is conspicuous, more or less enclosing and hiding the calyx. It is usually densely pubescent with small stellate hairs, sometimes

[12] In this monograph flower length indicates the distance from the base of the calyx to the tip of the petals, disregarding the exserted staminal column.

subglabrous. The involucral lobes are entire, linear to broadly lanceolate or obovate, varying in number (8 is a common number), and usually about as long as the calyx. They are attached to the pedicel immediately below the calyx and are persistent until maturity of the fruit.

The calyx (pl. 17, fig. 1) is campanulate, usually uniformly and densely stellate-pubescent without, sometimes subglabrous or with longitudinal ridges of hairs. On the inside it is short-lanose near the tips of the lobes, sub-lepidote below. The lobes are variable in number (generally five), essentially deltoid-lanceolate, and are usually unequal in size. The persistent calyx may or more often may not entirely enclose the mature fruit.

The petals (pl. 17, fig. 2) are five in number, asymmetrically obovate-cuneate, usually emarginate at the top, unguiculate toward the base and uncinate-auriculate on one side of the claw. On the outside they are slightly stellate-pubescent basally or subglabrous.

The thin, glabrous, staminal column (pl. 17, fig. 3) is usually one-third longer than the corolla and is five-lobed apically. The many unilocular, oval anthers are borne towards the tip on short filaments. From the top of the staminal column are exserted ten style branches, each with a capitate stigma. The ovary appears as a swelling at the base of the staminal column and is sessile, five-carpellate, five-ovulate.

The fruit (pl. 17, fig. 5) is depressed-globose, medium-sized in the *Malvaviscus arboreus* complex, but larger in *Malvaviscus candidus*. It consists of five stone-like, one-seeded carpels enclosed by a fleshy covering which soon dries, allowing the carpels to separate easily. A small reniform, basally attached seed is found in each carpel. Often only two or three of the carpels of the fruit mature.

Of the morphological characters, few seem to be of diagnostic value. The habit of the plant seems to vary with the environment, as does to some extent the type of inflorescence. The structure of branch, petiole, and pedicel is essentially uniform in the genus, as is the type of stipule. The internal structure of the flower is also essentially uniform throughout the *Malvaviscus arboreus* complex, just as it is, for example, in the Cruciferae, and is of little value for taxonomic delimitation within *Malvaviscus arboreus*. In addition, many herbarium sheets of *Malvaviscus* are with but one or two flowers, the removal and boiling of which would leave little critical flower material for the next observer. Also the type of fruit differs

significantly only between the *Malvaviscus arboreus* complex and *Malvaviscus candidus,* two species which are already amply separated on other characters. Moreover, herbarium specimens of *Malvaviscus* rarely contain fruit, and it would be impractical and unwise to base taxonomic units on this character unless absolutely necessary for a natural classification. The form of the involucre and of calyx is variable even on flowers of the same plant and is of taxonomic value only in a limited way. Similarly, type of leaf margin and structure of the staminal column offer little critical evidence to the taxonomist.

However, the fundamental difference in leaf shape, the type and degree of pubescence (in part), and the size of the flower seem to offer a broad basis for taxonomic segregation. Yet there is not a single character in the genus that by itself is of constant value for critical delimitation within the *Malvaviscus arboreus* complex.

Taxonomic Relationships and Suggested Generic Changes

Delimitation of taxonomic groups: The Malvaceae belong, of course, to the order Malvales of the Polypetalae. There has been great diversity of opinion as to how many families should be recognized in this order, from two to nine distinct families having been accepted by various authorities. However, since the early eighteen-hundreds the family Malvaceae has been distinct and generally recognized as an entity with essentially its modern limits, defined especially by the presence of unilocular anthers and monadelphous staminal column.

Within the Malvaceae subfamilies, tribes, and subtribes have been recognized chiefly on the basis of fruit characters. Perhaps the most useful and generally accepted division of the family is that of Gray,[13] in which he recognized, on the basis of number and arrangement of carpels, mode of dehiscence of the fruit, and morphology of the staminal column, four tribes: the Malopeae, Malveae, Ureneae, and Hibisceae. The tribe Ureneae, of which *Malvaviscus* is a member, is distinguished by having five uniovulate carpels, ten style-branches, the staminal column antheriferous along the upper part (but not at the truncate or five-toothed summit), and the seeds ascending, with a superior radicle. Among the genera included in this tribe are *Malachra, Urena, Pavonia,* and *Malvaviscus. Malvaviscus* is distinguished from the other genera

[13] Syn. Fl. N. Am. 1[1]: 294–338. 1897.

in having a "fleshy" or "drupaceous" fruit. However, the genus is apparently as closely related to *Pavonia* as are the "dry-fruit" genera of the Ureneae to one another.

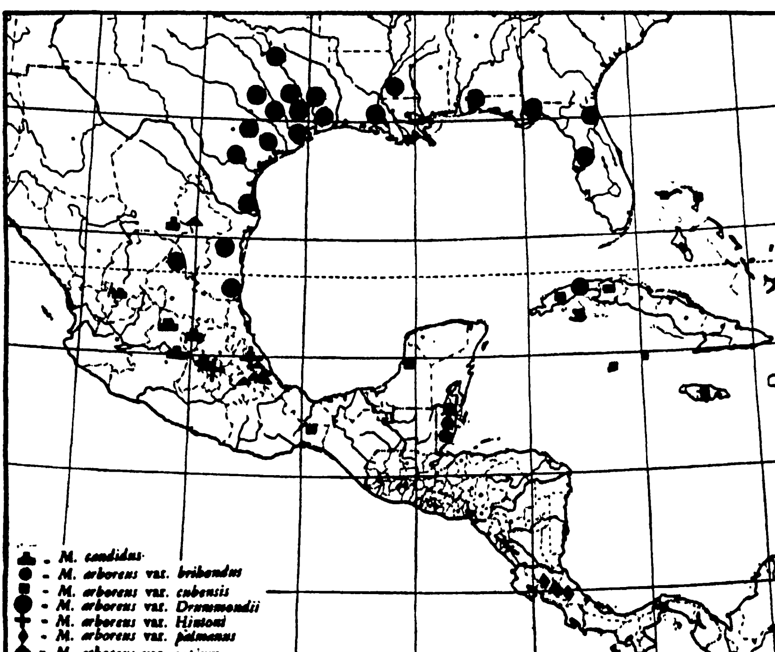
Proposed generic changes: The dividing line between *Malvaviscus* and *Pavonia* has been difficult to recognize. Just where does the "dry" fruit of *Pavonia* stop and the "fleshy" fruit of *Malvaviscus* start? In the mature fruit of *Malvaviscus* the outer "fleshy" covering dries and finally ruptures exposing the carpels. In *Pavonia* the "dry" outer wall of the ovary holds the carpels together until maturity. The difference is in the thickness of the outer ovary wall which, however, in both genera becomes dry and ruptures at maturity of fruit. An additional and more distinct division between the two genera is possible by using the old Candollean character for subdivision of *Malvaviscus* into the sections *Anotea* and *Achania,* namely whether or not the petals are auriculate at the base. Even de Candolle questioned whether the section *Anotea* belonged in *Malvaviscus.* It is here proposed to transfer this section (raised by Kunth to generic rank) with its few and in some cases unrecognizable species to *Pavonia.* Thus *Pavonia* will include species without auriculate petals while *Malvaviscus* will include only those species with auriculate petals. This will necessitate the transfer of but two undoubted species of *Malvaviscus* to *Pavonia,* both of which evidently should be transferred anyway on fruit character alone. Thus *Malvaviscus Palmeri* Baker f. (*Malvaviscus cinereus* Baker ex Robins. & Greenm., *Pavonia amplifolia* Standl.) should be *Pavonia Palmeri* (Baker) Schery, and specimens heretofore incorrectly determined "ex char." as *Malvaviscus acerifolius* Presl should be *Pavonia firmiflora* Schery n.sp. Both of these species have a "dry" fruit as well as non-auriculate petals. They are treated in this monograph as excluded species.

Geographic and Climatic Range of the Genus

Malvaviscus is native to the Western Hemisphere, although a few plants have evidently been introduced into the Philippines and Malaya and are growing there as escapes. The genus occurs indigenously from Peru and northern Brazil to the southern United States and also in the West Indies. *Malvaviscus arboreus* and its varieties are distributed generally throughout this range. The other species are found only in limited areas, one in central Mexico, another in Brazil. *Pavonia firmiflora* and *Pavonia Palmeri* (heretofore included in *Malvaviscus*) are confined to western Mexico.

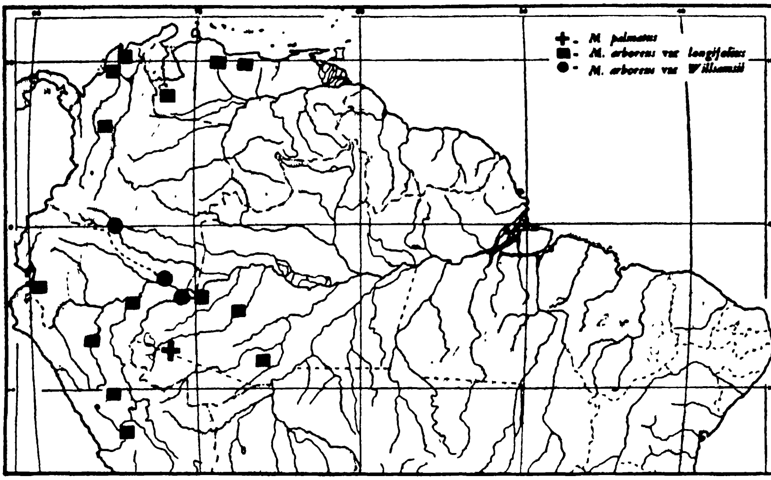
Maps 1–6 show the present known distribution of the species and varieties of *Malvaviscus* and of the two above-mentioned species of *Pavonia*. It is interesting to note that certain groups have be-

Map 1. Showing distribution of *M. arboreus*.

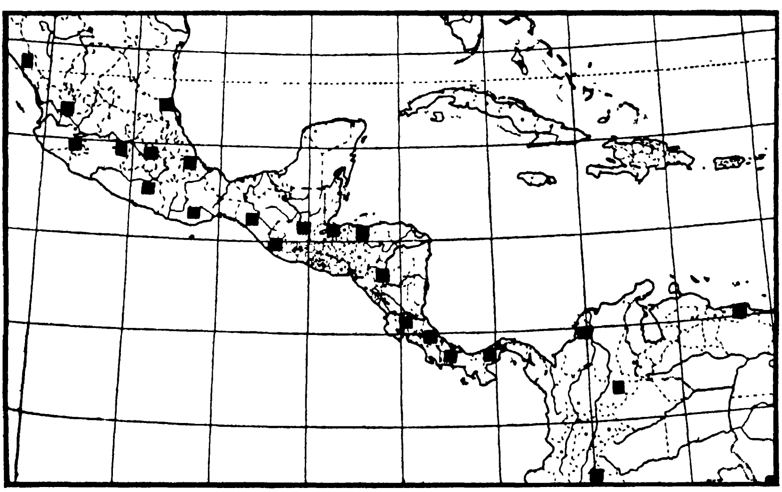


Map 2. Showing distribution of *M. candidus* and *M. arboreus* vars. *brihondus*, *cubensis*, *Drummondii*, *Hintoni*, *palmanus* and *sepium*.

come locally segregated and divergent enough to warrant varietal classification (vars. *palmanus, brihondus, sepium, Hintoni,* etc.), while others are very widespread, overlapping, and more or less



Map 3. Northern South America showing distribution of *M. palmatus* and *M. arboreus* vars. *longifolius* and *Williamsii.*

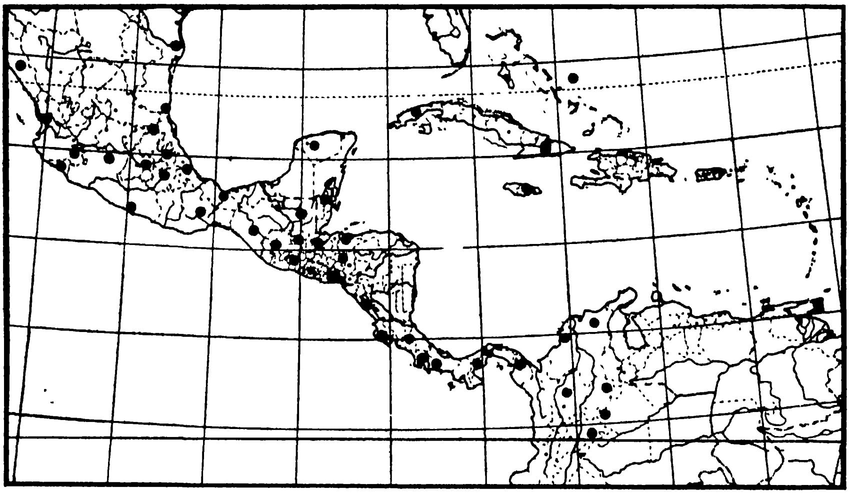


Map 4. Showing distribution of *M. arboreus* var. *penduliflorus.*

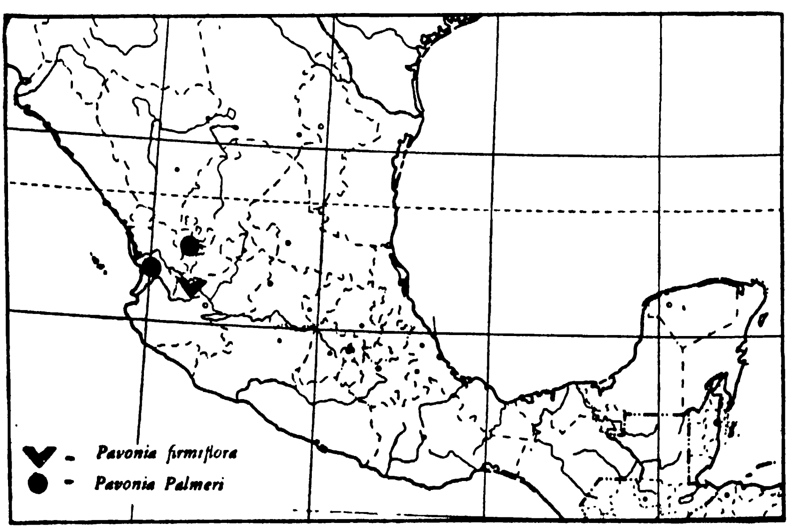
artificially delimited, evidently the parent stock from which local segregations are occurring (*Malvaviscus arboreus* and vars. *penduliflorus, mexicanus,* etc.).

Malvaviscus is quite tolerant of geographic-climatic differences. It is found growing from near sea-level to highlands of 2500 meters

as, for example, in Panama, where plants can be found within sight of mangrove swamps (Puerto Armuelles) while about a hundred kilometers towards the interior it is abundant near the lower slopes



Map 5. Showing distribution of *M. arboreus* var. *mexicanus.*



Map. 6. Map of Mexico showing distribution of *P. firmiflora and P. Palmeri.*

of Volcan de Chiriquí. In Mexico the genus is found in the hot, steaming forests of the Tehuantepec Peninsula and the high, cool plateau region near Mexico City. Plants of northwest Mexico and Texas grow in open semi-arid regions (damp river bottoms, etc.)

while those of Costa Rica and Panama may occur in dense rain-forests. Apparently there are ample geographic-climatic forces pressing for speciation. That these forces have had relatively little effect (in the sense of forming distinct, isolated species) testifies again as to the plasticity and variability of the genus.

Evidence for Taxonomic Conclusions

Study of natural populations: In *Malvaviscus,* populations, in the sense that the term is used for dense, isolated groupings or clusters of herbs and shrubs in the United States, do not occur. Rather, whole regions, perhaps several kilometers in extent, are found in the tropics where the plants are relatively abundant. Scarcely ever more than three or four separate plants grow side by side, and numerous single individuals occur frequently. The plants trail over shrubbery, are more or less shrub-like in open areas, and frequently in the forest can be found liana-like reaching almost to the tops of the trees. A single plant may spread over an area seven or eight meters in diameter and perhaps overlap partly the area occupied by another *Malvaviscus.*

In no case have I found hundreds of *Malvaviscus* plants within a small area, able to be collected, analyzed and counted, as are many North American plants used in population studies. Nevertheless, in areas even kilometers in extent, as, for example, moist stream banks, it seems plausible to assume that all the plants of this genus are apt to be rather closely related inasmuch as it may be tens or even hundreds of kilometers before another such area is encountered.

Examination of a young stem in flower from every accessible plant in such an area in Chiriquí, Panama, showed that a general similarity in certain characters existed (viz. general leaf shape; broader structural features of calyx, corolla, etc.), but that tremendous individual variation in certain specific characters (viz. number, length, and shape of calyx and involucre lobes, type of serration of leaf, continuity of pubescence, etc.) was also evident. It is not hard to imagine that a taxonomist unfamiliar with the genus, given two extremes from the "population," might consider the specimens as different species. Yet all intergrading degrees of variation exist, sometimes even on the same plant. The only conclusion that seems tenable is that individuals of *Malvaviscus* exhibit great variability, whether due to ploidy, hybridization, or other causes. Photographs of some specimens from this "popula-

tion" are presented in plate 15. Similar examination of a "population area" in Vera Cruz, Mexico, though not as extensive, supported these findings on individual variabilty.

Examination of greenhouse plants: That certain variations in leaf shape are of no taxonomic value (although, as will be shown directly, the manner of variation may be significant) can be shown by examination of living *Malvaviscus* plants. On the same plant from comparable stems can be found both semi-lobed and unlobed leaves. Figure 1 of pl. 16 shows two leaves from a plant which had been growing in the greenhouse of the Missouri Botanical Garden for a number of years. That these greenhouse plants, evidently brought from southern Mexico, had the potentiality for "acting queer" as far as leaf shape is concerned, was demonstrated when cuttings were made and rooted. The first-formed leaves of the cuttings were unlike any leaf ever seen on the parent plant, although genetically parent and scion were the same. However, after about eight or nine nodes, the cuttings developed leaves like the parents. A photograph of one such cutting appears in pl. 14.

Examination of herbarium material: From limited examination of living plants of *Malvaviscus,* it was evident that great variability was to be expected in herbarium material of the genus, and that many of the characters which normally (i.e., in other genera in other families) might be constant and of definite systematic value were worthless here.

Examination of all available herbarium material of *Malvaviscus* shows complete intergradation of all forms in the *Malvaviscus arboreus* complex. Segregation of specimens of different appearance can be accomplished only with overlappings and intergradations. Intense segregation leads to a multitude of intergrading forms all of slightly different appearance (over 100 such segregated forms, all marginally indistinct, are possible in sorting *Malvaviscus* specimens). Obviously such intense segregation is worthless in any genus as variable as *Malvaviscus*. It leads to nothing more than artificial forms to which must continually be added others as more specimens are collected. Keying out of such forms is impossible, even on a distributional basis alone.

Thus in order to find some clear-cut specific characters of taxonomic value in the *Malvaviscus arboreus* complex, individual characteristics were scrutinized separately in a series of specimens ranging from South America to Texas. In approximately 400 specimens examined for distinctive characters in leaf shape, pubescence

TABLE I

NUMBER OF SPECIMENS FROM DIFFERENT LOCALITIES SHOWING CONTRASTING CHARACTERS.

	leaf shape					leaf pub.		pet-iole		stem pub.		involucre lobes			flower length			leaf length			leaf margin			
						stellate	simple	pilose	pubescent	decurrent	continuous	wide	interm.	thin	< 3 cm.	3-4.5 cm.	> 4.5 cm.	short	interm.	long	sinuate	dentate	serrate	jagged
Peru	6	2	0	9	0	12	5	10	7	5	12	9	7	0	0	4	8	0	3	14	7	5	1	4
Brazil	3	3	0	0	0	1	2	2	1	0	3	4	2	0	0	2	3	0	0	6	2	0	3	1
Venezuela	3	4	0	1	0	2	5	8	0	4	4	0	2	6	0	4	4	0	4	3	2	1	4	1
Colombia	6	5	0	1	0	8	1	7	3	3	6	1	8	2	0	8	1	0	2	9	2	4	3	1
Panama	10	25	1	1	0	36	1	31	6	21	14	1	13	23	0	28	7	2	16	18	14	14	6	3
Costa Rica	0	16	14	7	2	24	11	34	3	12	24	0	16	19	2	16	13	5	16	15	11	9	11	6
Nicaragua	0	0	3	3	1	1	8	6	0	0	7	0	6	0	3	4	0	1	5	1	4	1	2	0
Honduras	0	13	4	2	0	11	9	18	1	5	15	0	6	15	0	12	7	0	11	9	7	4	3	6
Salvador	0	1	0	1	1	0	3	3	0	0	3	0	0	3	1	2	0	0	3	0	0	3	0	0
Br.Honduras	0	2	11	0	0	13	0	12	2	4	9	0	9	4	12	0	0	3	8	2	1	10	1	1
Guatemala	0	22	14	10	5	30	19	32	13	16	35	1	19	28	10	28	5	8	28	15	10	23	8	10
Yucatan	0	26	4	2	0	29	2	29	3	7	23	4	22	5	25	2	0	9	21	1	4	22	3	0
So. Mexico	0	9	2	4	1	11	5	14	2	10	6	0	11	4	7	6	2	4	11	1	4	10	1	1
West Mexico	0	11	1	2	0	4	10	13	1	6	8	0	5	9	5	7	1	2	5	7	0	12	1	1
Cent.Mexico	1	6	4	9	3	10	13	23	0	11	12		13	9	6	9	4	3	14	6	3	13	7	0
East Mexico	0	17	3	5	0	7	17	23	2	19	6	3	17	5	19	4	1	9	15	1	9	14	1	1
No. Mexico	0	3	0	2	4	1	8	8	1	5	4	0	5	4	6	3	0	3	6	0	1	6	2	0
So. Texas	0	0	0	13	18	3	29	31	0	7	25	0	19	13	24	6	0	3	21	8	2	26	4	0
Cent.Texas	0	0	0	4	18	0	22	21	0	2	20	0	10	12	19	1	0	1	14	7	4	14	4	0

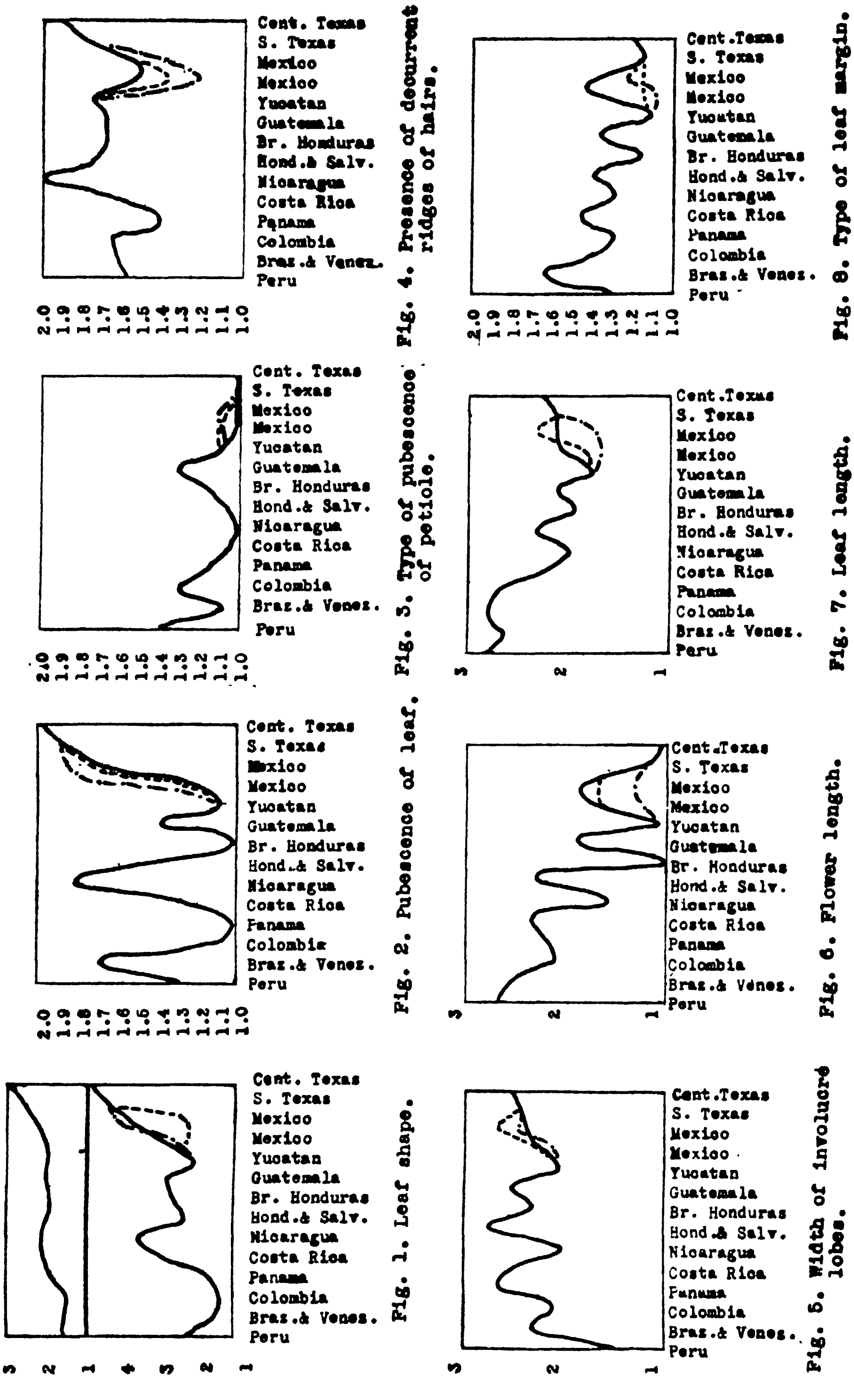


Fig. 1. Leaf shape.

Fig. 2. Pubescence of leaf.

Fig. 3. Type of pubescence of petiole.

Fig. 4. Presence of decurrent ridges of hairs.

Fig. 5. Width of involucre lobes.

Fig. 6. Flower length.

Fig. 7. Leaf length.

Fig. 8. Type of leaf margin.

of leaf, of petiole, and of stem, shape of involucre lobes, length of flower and of leaf, and type of leaf margin, not a single clear-cut difference was found. Later examination dealing with the number of flowers per inflorescence, presence or absence of petiole callus, relative length of the staminal tube, type of venation, pubescence of veins, and concentration of stamens, showed a similar lack of clear-cut characteristics in Panamanian specimens alone.

However, one point of significance was noted about several of these characters: they differed, *on the average,* for specimens from different geographical areas. Thus in Colombia leaves of specimens, by and large, are broad and cordate at the base, whereas in British Honduras "average" leaves are narrow and rounded. Again, flowers in South American specimens, although often the same length as those in Texas specimens, show an *average* length significantly greater than the *average* for Texas flowers.

Table I gives the tabulated results of these examinations, and figs. 1–8 show these results put into graph form for individual characters. Of course the intrinsic value as read from the ordinants of these graphs (geographical distribution read from abscissas) is not significant. These values were obtained in mathematical form by arbitrarily assigning one extreme of a given character a high number, the other extreme a low number. Then an average for all specimens of the region was taken and tabulated. Thus if half the specimens showed the high number character and half the low, the average would be midway between these two. Significance for the character can only be assumed when there is a pronounced rise or dip in the curve at a certain geographical region. For example, reference to figs. 1–8 will show a steep dip or rise for many characters in the region of British Honduras. From this it can be assumed that the available British Honduran specimens are more or less constantly different in many ways from those of neighboring regions and probably constitute a taxonomic unit.

Yet examination of these graphs as a whole shows a remarkable lack of "significant characters" for any one region. Rather, the dips occur indiscriminately for various characters, now in one geographical region now in another. With one or two exceptions, there is no continuous gradation of characters from South America to North America.

These results were assumed to indicate further that in the *Malvaviscus arboreus* complex, there are no clear-cut, distinctly different taxonomic units, at least as far as geographical distribution is con-

cerned. In other words, that although no distributional differences of specific degree existed, perhaps numerous overlapping groups, viz. from British Honduras, Texas, etc., were deserving of varietal separation. Also it seemed that of the characters examined, basic leaf shape and length of flower were perhaps fundamental and would be of value as key characters. The other characters, seemingly, were useless or of limited value. Of course it must be remembered that tabulations and investigations of this kind are apt to show up only degrees of differentiation due to geographical isolation, and may or more probably may not show speciation due to biological isolation. However, in a genus such as *Malvaviscus*, where scarcely a constant character is to be found, any approach that may give a hint as to natural groupings is worth investigation.

Hybridization evidence: In another line of attack on the problem of taxonomy in the *Malvaviscus arboreus* complex, hybridization was attempted between var. *Drummondii* (Texas) and var. *penduliflorus* (southern Mexico?) growing in the Missouri Botanical Garden greenhouses. Although both varieties flower abundantly in the greenhouse, their blooming seasons do not coincide but do partly overlap. Variety *penduliflorus* blooms through the winter, spring and early summer; var. *Drummondii* in the autumn and sporadically at other times. This discrepancy between blooming seasons can be accounted for by the latitudinal season and day-length differences of the regions to which these varieties are indigenous.

Flowers of both varieties were early castrated, hand-pollinated a day or two later with pollen from the other variety, and then bagged (both opaque and translucent paper bags were tried). However, in no case would var. *penduliflorus* flowers set seed, even when self-pollinated. This was evidently due to greenhouse conditions, for greenhousemen cannot recall ever having seen this variety set seed at the Missouri Botanical Garden. Neither did any *Drummondii* flowers pollinated with *penduliflorus* pollen set seed; but so few *Drummondii* flowers were available at the proper time that this result is not significant. Normally, only a very small percentage of *Drummondii* flowers set seed in the greenhouse, even when self-pollinated. Thus from attempted greenhouse hybridizations, no conclusions could be reached as to the closeness of relationship in these two varieties. However, an incidental observation noted in herbarium material seemed to be supported: that there is an inverse relationship between the flower length in *Malvaviscus* and quantity of seed set. Smaller-flowered plants (as var. *Drummondii)* seem

to set more seed than larger-flowered ones (as var. *penduliflorus*), perhaps due to the fact that the pollen tube must push farther through the style in long-flowered types with a consequent lesser chance of reaching the ovary.

Even though no evidence that hybridization is possible in *Malvaviscus* was obtained from the greenhouse experiments, much circumstantial evidence exists that hybridization does occur in the genus. Firstly, many plants are intermediate in character and have never been exactly duplicated in later collections (specimens of *Malvaviscus arboreus, Pavonia firmiflora,* etc.). Secondly, geographic distribution of varieties makes contact possible with many other varieties (extended and overlapping range of *Malvaviscus arboreus* and such varieties as *mexicanus, penduliflorus,* etc.). Thirdly, there is usually a low percentage of flower fertility in living plants (plants examined in the field in Mexico, Costa Rica, and Panama showed that very few fruits matured in proportion to the number of flowers produced). Fourthly, hybridization is evidently not uncommon in the family Malvaceae (Kearney[14] on *Sphaeralcea,* Webber[15] on relationship in *Gossypium,* Skovsted[16] on chromosome numbers in the Malvaceae, etc.). In all probability appropriate experiments by competent geneticists and cytologists would show varietal hybridization to be exceedingly common in *Malvaviscus,* and even intergeneric hybridization with *Pavonia* possible.

Chromosome counts: Lack of proper technique by the author in making microspore chromosome counts, probably more than natural difficulties in the genus, made investigations along this line of no taxonomic value. Aceto-carmine smears of young pollen showed occasional evidence of a great many chromosomes, but these were so abundant, indistinct, and obscured by debris that counts were impossible. However, Skovsted[17] reports the occurrence of a diploid count of 84 chromosomes in *Malvaviscus.* This number fits in with the basic chromosome number of 7 found in the tribe Ureneae, a number Davie[18] would like to consider as basic for the family as a whole but which others (viz., von Kesseler,[19] Webber,[20] Skovsted,[17]

[14] Univ. Calif. Pub. Bot. 19: 1–128. *pls. 1–12. 1 fig.* 1935.

[15] Webber, J. M., in Jour. Agr. Res. 58: 237–261. 1939.

[16] Skovsted, A., in Jour. Genet. 31: 263–296. 1935 (*Malvaviscus,* p. 285); in Compt. Rend. Lab. Carlsberg 23: 195–242. 1941.

[17] loc. cit. 1935 and 1941.

[18] Davie, J. H., in Jour. Genet. 28: 33–67, *2 pls.* 1934.

[19] Kesseler, E. von, in Am. Jour. Bot. 19: 128–130, *pl. 9.* 1932.

[20] Webber, J. M., in Science, N.S. 81: 639–640. 1935.

Harland,[21] etc.) find unacceptable as ancestral for the entire Malvaceae. Although chromosome counts have scarcely been attempted in *Malvaviscus,* it is to be expected that when such are made a high degree of ploidy, perhaps to the octoploid or decaploid, will be found as in other Malvaceous genera.

Conclusions: From these several lines of investigation a conservative taxonomic treatment for the genus seems necessary. Since clear-cut, stable morphological characters of taxonomic value are lacking, lines of demarcation must necessarily be rather arbitrary and inclusive. Evidently the taxonomy should be made practical as well as following the indistinct varietal groupings as much as possible. Since the pattern of relationships is evidently reticulate through hybridizations rather than linear by descent, a key can only be constructed which may include closely related specimens in all of its main subdivisions. There is bound to be great varietal variability, and often the delimitation of a variety will need be arbitrary. Few groupings will deserve specific rank, since all intergrade and few show any evidence of either biologic or geographic isolation. In short, *Malvaviscus* (i.e. the *Malvaviscus arboreus* complex) seems best pictured as a reticulate background of several intermixing varieties *(Malvaviscus arboreus,* vars. *penduliflorus, mexicanus,* etc.) on which several newer varieties (vars. *palmanus, brihondus, sepium,* etc.) have superimposed themselves locally, perhaps due to a new favorable but non-isolating "mutation."

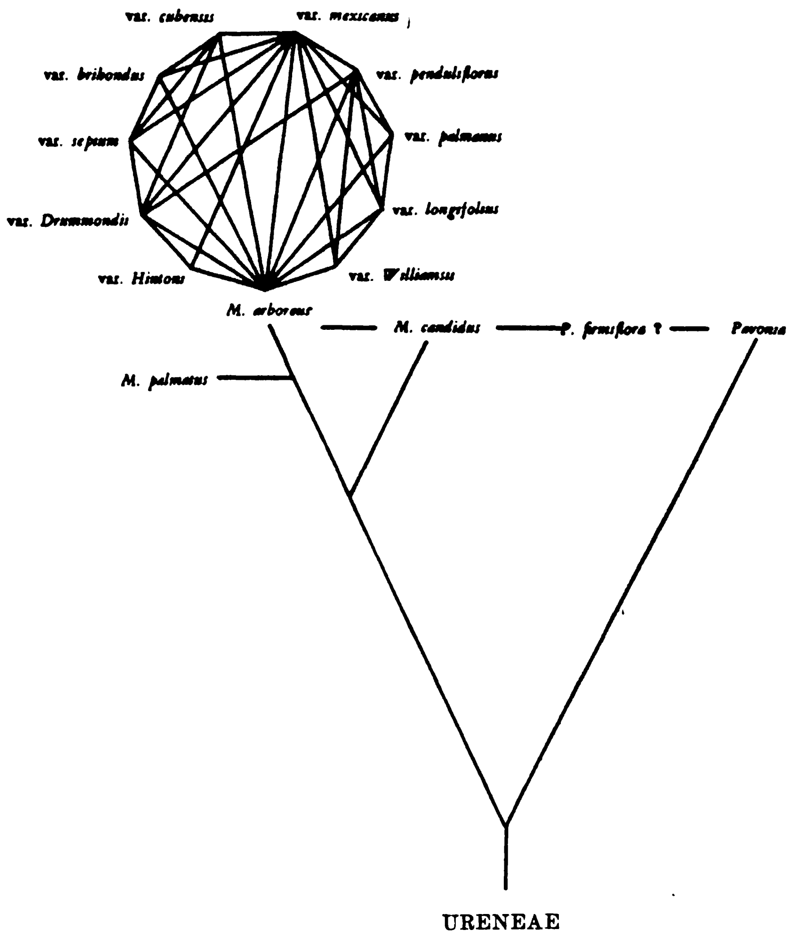
Phylogenetic Inferences

Although it is extremely hazardous to venture phylogenetic opinions, certain hypotheses can be presented regarding relationship of taxonomic groups and their derivation. From the previously mentioned circumstantial evidence concerning *Malvaviscus* and the Malvaceae as a whole, it seems reasonable to suppose that *Malvaviscus* is made up of a number of types, probably polyploid, which have not as yet become genetically isolated (except perhaps, *Malvaviscus candidus)* and are only partially geographically isolated. These types *(Malvaviscus arboreus* and its varieties) have evidently crossed back and forth with one another extremely often. As a result there is a reticulate relationship between *Malvaviscus arboreus* and its varieties, the biggest mixup occurring in southern Mexico. Marginal groups as vars. *Drummondii* in Texas, *Wil-*

[21] Harland, S. C. The Genetics of Cotton. London, Toronto. 1939.

liamsii in Peru, and perhaps *brihondus* of British Honduras and *palmanus* of Costa Rica, are probably the "purest" but nevertheless intergrading types. The promiscuous exchange of characters, possibly coupled with degrees of ploidy, could, at least in part, account for the great variability and intensification of phenotypes even in small populations.

TABLE II



The genus as a whole is closely related to *Pavonia* and may have split off from that genus rather recently. Assuming this to be the case, *Malvaviscus* is in an early stage of speciation within itself, the numerous varieties as yet lacking barriers which would lead to complete speciation. *Malvaviscus candidus* must have been an early segregation from the *Malvaviscus arboreus* complex, perhaps oc-

curring soon after the split with *Pavonia*. The same may be true for *Malvaviscus palmatus*, or this species may be a broadcross hybrid or a monster. Table II represents a possible phylogenetic "tree" for *Malvaviscus*. Actually the figure should be three dimensional with all the *Malvaviscus arboreus* varieties at about the same level. Also it is not intended to show "pure" lineage for the Ureneae, for this tribe in its early stages may have had interconnections with *Hibiscus*-like forms, etc.

Common Names and Uses

Malvaviscus has been recognized by many peoples who have given vernacular names to the plant. As mentioned previously, an early Aztec name for *Malvaviscus* was "Atlat Zopillin."[22] A supposed Maya name is "taman chich." The Maya-Spanish name for the plant was "manzanita," a name still used in many parts of Central America. Other names reportedly used today in Latin America for *M. arboreus* and its varieties are: "algodoncillo," "amapola," "amapolilla," "arete," "arito," "candelillo," "chilito colorado," "chilmecate," "chocho," "claveloncillo," "esbequen blanco," "flor de arito," "flor de avispa," "fucsia silvestre," "manzana," "manzanilla," "manzanita guesillo," "mapola," "monaguillo," "monacillo," "monecillo," "obelisco," "panelita," "papito de monte," "para tisano" (for root), "pico de gorrion," "quesillo," "quesito," "resuscitado de monte [mente?]," "sobon," "tulipancia," "uba," and doubtless several others. *M. candidus* is known as "monacillo blanco." "Waxmallow" and "Turk's-cap Hibiscus" are two English names for *M. arboreus* var. *penduliflorus*, which is frequently cultivated as an ornamental in our southern states where it has been introduced, evidently from Mexico. "May-apple" is the name given to *Malvaviscus arboreus* var. *Drummondii* in Texas where the fruits are reported to be eaten both raw and cooked. *Malvaviscus arboreus* is also reportedly called "sugar bark" in Jamaica.

Perhaps the reason why *Malvaviscus* has acquired so many local names in Central America is that it is of some economic importance to the natives, and thus attention has been focused on it. Rubbing the head with leaves of the plant supposedly cures scaly head, and

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[22] The early Spanish explorer, Francisco Hernandez, who was sent to Mexico by Philip II from 1570 to 1576 as expedition naturalist, records this name in his 'Nova Plantarum, Animalium, Mineralium Mexicanorum Historia,' which was published at Rome in 1651.

a decoction of the leaves is said to be used as a diuretic and in treatment of stomach ailments. Also the fruit of *Malvaviscus* is edible, though scarcely appetizing.

Taxonomy

ABBREVIATIONS USED IN THIS SECTION

A—Arnold Arboretum Harvard University, Jamaica Plain, Massachusetts.
F—Field Museum of Natural History, Chicago, Illinois.
G—Gray Herbarium of Harvard University, Cambridge, Massachusetts.
L—Museo de Historia Natural de la Universidad de Lima, Lima, Peru.
M—Missouri Botanical Garden, St. Louis, Missouri.
NY—New York Botanical Garden, New York City.
US—United States National Herbarium, Smithsonian Institution, Washington, D. C.

MALVAVISCUS [Dill.] Adans.

Malvaviscus [Dill. Hort. Elth. **2**: 210. *pl. 170. fig. 208.* 1732] Adans. Fam. **2**: 399. 1763; Cav. Tert. Diss. Bot. 131. *pl. 48, fig. 1.* 1787; Medic. Malv. 49. 1787; Juss. Gen. Plant. 304. 1791; Moench, Meth. Suppl. 208. 1802; HBK. Nov. Gen. & Sp. **5**: 285. 1821 [1822]; DC. Prodr. **1**: 445. 1824; Descourt. Fl. Ant. **6**: 11. *pl. 383.* 1828; G. Don, Gen. Hist. Dichl. Pl. **1**: 475. 1831; Presl, Reliq. Haenk. **2**: 135. 1835; Endl. Gen. Pl. 982. 1836–40; A. Rich. Bot.—Pl. Vasc., in Sagra, Hist. Nat. Cuba, 131. 1845(?); Gray, Gen. Pl. U. S. 77. *pl. 131.* 1849; Benth. & Hook. Gen. Plant. **1**: 206. 1862; Baill. Hist. Pl. **4**: 148. 1873; Hemsl. Biol. Cent.-Am. Bot. **1**: 118. 1879; K. Schum. in Engl. & Prantl, Nat. Pflanzenfam. **3**^{6}: 46. 1890; Mart. Fl. Bras. **12**^{3}: 535. 1892; Gray, Syn. Fl. N. Am. **1**: 297, 332. 1897; Small, Fl. S.E. U. S. 733. 1913; Standl. in Contr. U. S. Nat. Herb. **23**: 773. 1923.

Hibiscus L. Sp. Pl. **2**: 694. 1753, in part; Browne, Hist. Jam. 284. 1756.

Achania Sw. Prodr. Fl. Ind. Occ. 102. 1788; Ait. Hort. Kew. **2**: 459. 1789; Schreb. in L. Gen. Plant. ed. 8, **2**: 469. 1791; Sw. Fl. Ind. Occ. **2**: 1221. 1800; Willd. in L. Sp. Plant. **3**: 839. 1801; Spreng. in L. Syst. Veg. ed. 16, **3**: 100. 1826.

Pavonia Cav. Ic. **5**: 20. *pl. 434.* 1799, in part; DC. Prodr. **1**: 445. 1824, as syn.

Anotea (DC.) Kth. ex Ulbrich in Fedde's Rep. Spec. Nov. **14**: 108. 1915, as doubtful section in DC. Prodr. **1**: 445. 1824.

Perennial vine-like or shrub-like plants with many-branched gray-brown terete stems. Leaves alternate, stipulate (stipules caducous), petiolate, variously lobed, usually stellate pubescent, especially on lower surface. Inflorescence leafy, with single axillary flowers or with terminal or subterminal cyme-like clusters of flowers. Involucre of 6–16 entire, linear, lanceolate, or spatulate lobes. Calyx campanulate, usually with 5 lanceolate or deltoid lobes, variously pubescent. Corolla contorted, tube-like, never expanded. Petals 5, obovate-cuneate, usually emarginate, unguiculate and auriculate basally. Staminal column exserted, 5-parted apically, bearing many stamens toward the apex. Style branches 10, each with capitate stigma. Ovary 5-carpellate. Fruit with outer fleshy covering (dry at maturity) surrounding five stony carpels. Carpels 1-seeded, indehiscent but often separating at maturity when outer covering dries.

Type species: **Malvaviscus arboreus** Cav. Tert. Diss. Bot. 131, *pl. 48, fig. 1.* 1787.

KEY TO THE SPECIES AND VARIETIES

A. Flower large, petals about 8 cm. long; staminal column about 12–15 cm. long, more or less curved-ascending; filaments about 1 cm. long..........*1. M. candidus*

AA. Flower smaller, petals less than 6 cm. long; staminal column less than 7 cm. long, not curved-ascending; filaments less than 3 mm. long.

B. Leaves palmately or digitately lobed (known only from type description of greenhouse plant)..*2. M. palmatus*

BB. Leaves less deeply lobed, sublobate, or unlobed, never palmately or digitately lobed.

C. Leaves lobed or sublobate.

D. Lateral lobes of leaves usually manifest and more or less acute; branchlets, petioles or lower leaf-surface very densely hairy, often velvety (occasionally lightly pubescent or hirsute, or almost glabrous, but then lobes of leaves usually large and very prominent); upper leaf-surface usually predominantly stellate-haired; involucral lobes never foliaceous; flowers red..*3. M. arboreus*

DD. Lateral lobes of leaves obtuse or small; branchlets, petioles and lower leaf-surface variously pubescent but usually not with long dense hairs; plants either with upper leaf-surface more or less predominantly straight-haired, with leaves lightly pubescent and scarcely lobate, with involucral lobes foliaceous, or with whitish flowers....(vars. of *M. arboreus*)

E. Leaves slender (decidedly longer than broad), with shallow jagged lobes, rounded or but slightly cordate at base; involucral lobes never foliaceous.

F. Flowers white; central Mexico............*3d. M. arboreus* var. *Hintoni*
FF. Flowers red; Mexico to South America, West Indies.
G. Flowers more than 4.2 cm. long, robust..*3h. M. arboreus* var. *penduliflorus*
GG. Flowers 2.3–4.2 cm. long...........*3f. M. arboreus* var. *mexicanus*
GGG. Flowers less than 2.3 cm. long; chiefly West Indian...*3b. M. arboreus* var. *cubensis*
EE. Leaves broad (as broad or nearly as broad as long), usually conspicuously cordate at base.
H. Involucral lobes expanded and more or less foliaceous, broadly lanceolate; South America.............*3j. M. arboreus var. Williamsii*
HH. Involucral lobes linear, linear-oblanceolate, or linear-ovate, usually broadest at or above the middle.
I. Leaves uniformly and symmetrically obtuse-lobate; pubescence of the upper leaf-surface almost always predominantly simple; branchlets and petioles usually uniformly short-pubescent; Gulf States of the United States and Mexico........*3c. M. arboreus* var. *Drummondii*
II. Lobed and unlobed leaves on same plant or lobes irregular and varying in size; pubescence of upper leaf-surface usually predominantly stellate; branchlets and petioles usually glabrous, scabrous, long-haired, or with longitudinal ridges of hairs; Central Mexico to South America; West Indies.
J. Calyx slightly (less than twice) longer than broad, subturbinate, or short-cylindric with more or less flaring or spreading lobes, tube scarcely longer than fruit.
K. Flowers more than 4.2 cm. long, robust...*3h. M. arboreus* var. *penduliflorus*
KK. Flowers 2.3–4.2 cm. long........*3f. M. arboreus* var. *mexicanus*
KKK. Flowers less than 2.3 cm. long; chiefly West Indies...*3b. M. arboreus* var. *cubensis*
JJ. Calyx about twice as long as broad, long-cylindric, with tube manifestly longer than fruit, contracted above fruit and enclosing it; leaves almost always unlobed; South America....................................*3e. M. arboreus* var. *longifolius*
CC. Leaves unlobed, essentially ovate-lanceolate.
L. Branchlets, petioles or lower leaf-surface very heavily haired, with a dense felt-like or velvet-like pubescence, or with long semi-rigid yellowish hairs...*3. M. arboreus*
LL. Branchlets, petioles and lower leaf-surface pubescent or glabrous, but pubescence never continuously so dense as to be velvet-like..(vars. of *M. arboreus*)
M. Involucral lobes broadly lanceolate (at least 3 mm. broad at the base), more or less foliaceous; South America...*3j. M. arboreus* var. *Williamsii*
MM. Involucral lobes linear or linear-lanceolate to obovate or spatulate (always less than 3 mm. broad at base), never foliaceous.
N. Calyx about twice as long as broad, long-cylindric, with tube manifestly longer than fruit, contracted above fruit and enclosing it; South America......................*3e. M. arboreus* var. *longifolius*
NN. Calyx slightly (less than twice) longer than broad, subturbinate, or short-cylindric with more or less flaring or spreading lobes, tube scarcely longer than fruit.

O. Leaves almost perfectly elliptic, broadest at the middle, with 3 large palmate veins from which lateral veins emerge almost at right angles; Costa Rica..............*3g. M. arboreus* var. *palmanus*

OO. Leaves from linear-lanceolate to ovate-cordate, broadest below the middle, with 3–7 large veins and variable reticulation patterns.

P. Flowers white; central Mexico........*3d. M. arboreus* var. *Hintoni*

PP. Flowers red.

Q. Leaves narrow, oblong-lanceolate, 2.5–3.5 times as long as broad; pubescence of upper leaf-surface predominantly stellate; petioles short (0.5–3.0 cm.); flowers small (2.0–2.5 cm. long); British Honduras......*3a. M. arboreus* var. *brihondus*

QQ. Leaves broader than in var. *brihondus,* lanceolate to ovate-cordate; pubescence of upper leaf-surface often predominantly straight-haired; petioles and flowers variable in length, usually longer and larger than in var. *brihondus*

R. Involucral lobes spatulate, broadest above the middle; flowers small (2.0–3.2 cm. long); upper leaf-surface predominantly straight-haired; Vera Cruz and Nuevo Leon, Mexico........................*3i. M. arboreus* var. *sepium*

RR. Involucral lobes usually linear or linear-lanceolate (if spatulate, upper leaf-surface without straight hairs); flowers large or small; pubescence of upper leaf-surface generally predominantly stellate.

S. Flowers more than 4.2 cm. long; robust..............
......................*3h. M. arboreus* var. *penduliflorus*

SS. Flowers 2.3–4.2 cm. long....*3f. M. arboreus* var. *mexicanus*

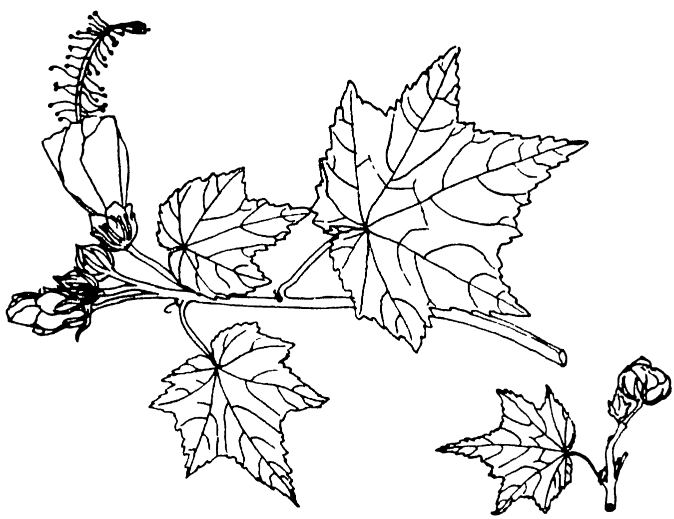
SSS. Flowers less than 2.3 cm. long; chiefly West Indies......
..........................*3b. M. arboreus* var. *cubensis*

1. **Malvaviscus candidus** DC. Prodr. 1: 445. 1824; Moc. & Sessé ex A. DC. Calcq. des Dess. *pl. 90.* 1874; Standl. in Contr. U. S. Nat. Herb. **23**: 774. 1923.

Malvaviscus Pringlei E. G. Baker ex Robins. & Greenm. in Am. Jour. Sci. III, **50**: 175. 1895; Standl. loc. cit. 774. 1923, in syn.

Shrubs, with upper branches, petioles and pedicels densely stellate-pubescent, the hairs often in clusters. Leaves large, up to 18 cm. broad, densely or thinly stellate-pubescent on lower surface, upper surface predominantly straight-haired; lobes 5, triangular-acute, dentate, often irregularly so, terminal lobe largest, basal pair smallest; veins (5 large palmate veins and many small reticulate ones) conspicuous, especially elevated on lower surface, usually heavily haired; petioles 2–20 cm. long; stipules linear, 5–7 cm. long, caducous. Inflorescence terminal or subterminal, or occasionally flowers solitary towards tip of the leafy branch; flowers large and showy, about 8 cm. long; involucral lobes generally 12, linear or narrowly linear-lanceolate, somewhat shorter than the calyx, pubescent; calyx about 2 cm. long, often inconspicuously ridged longitudinally, lightly

pubescent or subglabrous on the outside, glabrous inside except toward the pannose margins of the ovate-lanceolate calyx-lobes and the lower portion of the calyx-tube which is encrusted with fleshy hairs; corolla white, petals subretuse, lightly pubescent on the outside below the middle, with curled, simple, coarse hairs; receptacle convex; ovary depressed-globose; style usually 12–14 cm. long, curved upward, the style-branches 7–10 mm. long, pubescent; staminal column arcuate, usually 11–13 cm. long, 5-dentate, staminiferous in its upper half; filaments linear, about 1 cm. long, subglabrous; anthers about 2 mm. long. Fruit 1.5 cm. in diameter,



M. candidus, × approx. ⅓.

consisting of 5 brown-black, 1-seeded, ridged carpels which separate at maturity; seed reniform, about 6 mm. long.

Distribution: north-central Mexico (see Map 2).

Specimens examined:

MEXICO: COAHUILA—Saltillo, *Palmer 686* (A, F, G, M, NY, US). GUANAJUATO—Guanajuato, *Duges 281* (G). JALISCO—Colotlan, *Rose 2670* (G, US). QUERETARO—without exact locality, *Agniel 10621* (US). MEXICO—Mexico, *Rose & Hay 6354* (US); Molino, *MacDaniels 526* (F). MICHOACAN—Lake Cuitzeo, *Pringle 4132* (A, F, G, M, NY, US).

This species is very distinct from *Malvaviscus arboreus* and its varieties, being easily recognized by the large white flowers with up-curving staminal column and long filaments. Also the nearly star-shaped leaf is seldom found in *M. arboreus*.

It cannot be said that plate 90 of deCandolle's 'Calcques des Dessins de Mociño & Sessé's Flore des Mexique' is undeniably *Malva-*

viscus. The illustration, in some respects, rather indicates another genus, possibly *Hibiscus*. For example, only 5 style-branches are shown, the involucre or subcalyx appears almost foliaceous, the fruit somewhat capsule-like, and the seed is not reniform. Yet the whole set of Mociño & Sessé illustrations seems to a degree inaccurate as regards details, and it appears better to regard the above-mentioned characters as craftmanship inaccuracies rather than to consider the species name *candidus* as a "nomen dubium." This seems desirable, as in general appearance the Mociño & Sessé illustration could scarcely fit any other plant, having convolute corollas, auriculate petals, curved staminal column, etc., characters manifest in Baker's later-proposed type, *Malvaviscus Pringlei*.

2. **Malvaviscus palmatus** Ulbrich, in Verhandl. Bot. Ver. Prov. Brandenburg **50**: 89, *fig. 1.* 1908.

Since a specimen of this species (known only from the type) is not at present available for examination, the following free translation of Ulbrich's original description is given:

Glabrous shrub 3 m. high, with terete, striate branches and long-petiolate palmate leaves; stipules caducous; leaves 7-nerved, palmately dissected, deeply cordate, glabrous, paler beneath and very sparsely pubescent with simple and 3-rayed stellate hairs, 7-lobed, lobes lanceolate, usually caudate-subacuminate, repand, 5–10 cm. long, 1.5–2.0 cm. wide, cinereous-green, also puncticulate and pubescent with small adpressed hairs; petiole up to 15 cm. long; inflorescence axillary, subumbellate-racemose, with several short-petiolate palmately dissected leaves; flowers very large, with pedicels 1–2 cm. long; involucre 15–20 mm. long, 9-lobed, lobes linear-lanceolate, 12–15 mm. long, 1.5 mm. wide, acute, fringed with subrigid yellow hairs, after anthesis somewhat accrescent; calyx cylindric-campanulate, 18–20 mm. long, 5-lobed, nerves and margins fringed with small, crisp, rigid hairs; calyx-lobes deltoid-subacuminate, 5 mm. long; petals dark red, obovate-cuneate, obtuse, about 4 cm. long, about 22 mm. broad at the broadest part, unguiculate, ciliate with minute, crisp hairs, above sparingly and below densely pubescent with coarse, 3-rayed and fine simple hairs; staminal tube 6 cm. long or longer, tenuous, barely 1 mm. in diameter, apically with 5 acute lobes each 1 mm. long, 2 mm. from the top bearing stamens for 8 mm. of its length; filaments delicate, 1.5 mm. long; style exceeding the staminal tube only about 2 mm., 9-parted into subliguliform style branches each about 3 mm. long; stigmas sub-

capitellate; stigma, style and staminal tube dark violet; fruit subglobose, black, baccate, glabrous, about 10 mm. in diameter; carpels prominently nerved on the outside, subangulate, 1-seeded; seed subreniform, 6 mm. long, 2–3 mm. wide, glabrous, fuscous.

Distribution: Brazil (see Map 3).

Specimens examined: none available.

If the description and figure presented by Ulbrich are entirely accurate, *Malvaviscus palmatus* is indeed unlike any other *Malvaviscus* known. So distinctive are the deeply lobed palmate leaves that this species could not be confused with any other in the genus. From description only, it is difficult to say with surety that this species may not belong in the genus *Pavonia;* yet Ulbrich's description of the fruit and his excellent illustration of the type specimen indicate that this plant probably is a *Malvaviscus.* On the other hand, the original description does not state that the petals are auriculate, from which the inference is that the plant may be *Pavonia.* Certainty of identification will have to await examination of the type or some authentic specimen; meanwhile the species had best remain as *Malvaviscus palmatus.*

3. **Malvaviscus arboreus** Cav. Tert. Diss. Bot. 131, *pl. 48, fig. 1.* 1787; HBK. Nov. Gen. & Sp. **5**: 287. 1821 [1822]; DC. Prodr. **1**: 445. 1824; G. Don, Gen. Hist. Dichlamyd. Pl. **1**: 475. 1831; Spach, Hist. Nat. Veg. Phan. **3**: 369. 1834; Schlecht. in Linnaea **11**: 359. 1837; E. G. Baker in Jour. Bot. **37**: 344. 1899; Standl. in Contr. U. S. Nat. Herb. **23**: 775. 1923.

Hibiscus Malvaviscus L. Sp. Pl. **2**: 694. 1753.

Achania Malvaviscus (L.) Sw. Prodr. Veg. Ind. Occ. 102. 1788; Ait. Hort. Kew. **2**: 459. 1789 (possibly var. *mexicanus).*

Achania pilosa Sw. loc. cit. 102. 1788; ?Ait. loc. cit. 459. 1789; Sw. Fl. Ind. Occ. **2**: 1224. 1800; Lodd. Bot. Cab. *pl. 829.* 1817? (possibly var. *mexicanus* or *cubensis,* but better not to be used as namebringing synonym for either variety because of uncertainty of synonymy).

Achania mollis Ait., loc. cit. 459. 1789.

Achania coccinea Salisb. Prodr. 385. 1796.

Malvaviscus cordifolius Moench, Meth. Suppl. 208. 1802.

Malvaviscus acapulcensis HBK. Nov. Gen. & Sp. **5**: 286. 1821 [1822].

Malvaviscus concinnus HBK. loc. cit. 286. 1822.

Malvaviscus Balbisii DC. Prodr. **1**: 445. 1824.

Malvaviscus cordatus Balb. ex DC. loc. cit. 445. 1824, nomen nudum, in synon.

Malvaviscus mollis DC. loc. cit. 445. 1824; Mart. Fl. Bras. **12**^{3}: 538. *pl. 106.* 1892.

Malvaviscus pilosus DC. loc. cit. 445. 1824; Macfad. Fl. Jam. **1**: 64. 1837.

Achania concinna (Kth.) Spreng. in L. Syst. Veg. ed. 16, **3**: 100. 1826.

Malvaviscus acerifolius Presl, Reliq. Haenk. **2**: 135. 1835; Standl. in Contr. U. S. Nat. Herb. **23**: 775. 1923.

Hibiscus racemosus Willd. ex Steud. Nom. Bot. ed. 2, **1**: 760. 1841.

Malvaviscus spathulatus Garcke in Otto & Dietr. Allg. Gartenz. **21**: 321. 1853.

Malvaviscus velutinus Triana & Planch. in Ann. Sci. Nat. Bot. IV, **17**: 168. 1862; Mart. loc. cit. 1892, in synon.

Malvaviscus speciosus Lind. & Planch. ex Mart. loc. cit. 1892.

Malvaviscus arboreus var. *pilosus* Hitchc. in Ann. Rept. Mo. Bot. Gard. **4**: 64. 1893.

Malvaviscus arboreus var. *parviflorus* E. G. Baker in Jour. Bot. **37**: 345. 1899.

Malvaviscus Malvaviscus (L.) Millsp. in Pub. Field Mus. Bot. **2**: 73. 1900.

Malvaviscus Cutteri Standl. in Pub. Field Mus. Bot. **4**: 315. 1929.

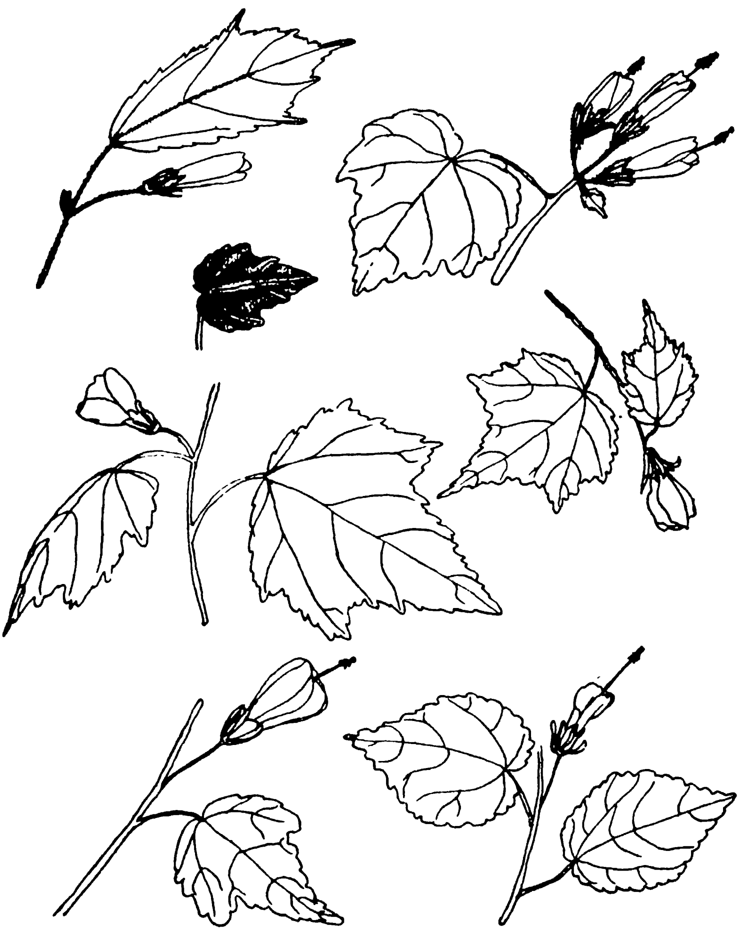
Shrub or vine-like plants with branchlets, petioles and pedicels densely velvety-pubescent (rarely almost glabrous), pubescence shorter and rougher in plants of certain subxerophytic regions. Leaves petiolate, variously lobed to entire, densely stellate-pubescent on lower surface, lightly to densely pubescent on upper surface, coarsely serrate to sinuate on the margins. Flowers 2.8–5.5 cm. long. Involucre usually densely pubescent, with 6 or more linear, linear-lanceolate or spatulate lobes approaching or exceeding the calyx in length. Calyx variously pubescent, generally with 5 subdeltoid lobes. Corolla red, of 5 generally deeply retuse petals. Mature staminal column usually exserted ⅓–¼ of its length.

Distribution: Mexico to Peru and Brazil; occasional in West Indies (see Map 1).

Specimens examined:

MEXICO: CAMPECHE—Carasayal, *Goldman 461* (US); Champoton, *Steere 1924* (F); Tuxpena, *Lundell 970* (A, F, M, NY, US). CHIAPAS—Comitan, *Goldman 904* (US);

Escuintla, *Matuda 95* (US); Huehuetan, *Nelson 3835* (US); Ocuilapa, *Nelson 3005* (G, US); San Vicente, *Goldman 864* (US); Teopisca, *Nelson 3454* (G, US), *Goldman 940, 983* (US); without definite locality, *Ghiesbreght 642* (G, M). DURANGO—Tamazula, *Gentry 5258* (G, NY). HIDALGO—Dublan, *Rose & Hay 5302* (US); Jacala, *Chase 7073* (F, G, M, NY), *Edwards 818* (F), *Lyonnet 1298, 1323* (US); Tula valley, *Pringle 8232* (A, F, G, M, NY, US), *9455* (G, US), *9688* (F G, M, NY, US). JALISCO—Barranca de Oblatos, *Barnes & Land 203* (F, US); Etzatlan, *Rose & Painter 7541* (G, US); Guada-



M. arboreus, × approx. ⅛.

lajara, *Pringle 8498* (F, G, M, NY, US); Lake Chapala, *Pringle 5973* (US); La Palma, *R.E.J. 111* (US). MEXICO—Churubusco, Federal District, *Orcutt 4294* (F); Mexico City, *Rose & Hough 4237* (US); Temascaltepec, *Hinton 3861* (A, NY, US), *5145* (M), *7184* (A, F, NY); Tlalpam, *Rose, Painter & Rose 8497* (G, NY, US). MICHOACAN—Morelia, *Arsène 34* (F), *2729* (US), *5494* (A, G, M, NY, US), *Dugès 173* (G). MORELOS—Cuernavaca, *Pringle 9275* (US), *Rose & Hough 4363* (US). NAYARIT—Acaponeta, *Rose, Standley & Russell 14210* (G, NY, US); between Tepic and Mazatlan, *Gregg 1110* (M); San Blas, *Maltby 1* (US). OAXACA—Cerro San Felipe, *Conzatti & Camino 2447* (US);

Oaxaca, *Conzatti & Gonzales 27* (M, US); Sierra de San Felipe, *Pringle 5609* (G, US). SAN LUIS POTOSI—Tamazunchale, *Kenoyer A373* (F). SINALOA—Coacoyolitos, *Ortega 6444* (G, US); Escuinapa, *Ortega 5183* (US), *6114* (A, G); Mazatlan, *Rose, Standley & Russell 14096* (G, NY, US); Villa Union, *Lamb 399* (G, M, NY, US), *Rose, Standley & Russell 13939* (NY, US). TAMAULIPAS—Chamal Hda., *Wooton* (US); Tampico, *Kenoyer 772a* (F). VERA CRUZ—Fortuno, *Williams 8977* (F); Juana Ramirez, *Palmer 470* (US); Rinconada, *Schery 204, 206* (M). YUCATAN—Chichankanab, *Gaumer & sons 23686* (F, G, NY, US); Uxmal, *Schott 643* (F), *Steere 2020* (F).

GUATEMALA: CHIMALTENANGO—Chimaltenango, *Standley 79935* (F, US); Patzum, *Standley 61483* (A, F); Tecpam, *Skutch 541* (A, F, NY, US). CHIQUIMULA—Amatillo, *Steyermark 30505* (F); Chiquimula, *Steyermark 30615* (F); Ipala, *Steyermark 30360* (F). HUEHUETENANGO—Huehuetenango, *Holway 766* (US), *Standley 81929* (F, M); Quen Santo, *C. & E. Seler 2681* (A, G, US); San Miguel Acatan, *Skutch 1021* (A, F, NY). JALAPA—Jalapa, *Steyermark 32851* (F). JUTIAPA—Asuncion Mita, *Steyermark 31959* (F); Jutiapa, *Standley 75248* (F, M). PETEN—Tikal, *Cook & Martin 63* (G, US), *197* (US). QUEZALTENANGO—Zunil, *Steyermark 34989* (F). QUICHE—San Miguel Uspantan, *Heyde & Lux 2920* (G, M, NY, US); WITHOUT DEFINITE LOCALITY—*Heyde 193a* (US). SACATEPEQUEZ—Antigua, *Standley 61127* (F); Duenas, *Standley 63263* (F); Santa Lucia, *Popenoe 690* (US); Santiago, *Gomez 822* (US); Volcan Acatenango, *Kellerman 4819* (US). SAN MARCOS—Chamac, *Standley 66190* (F); Tajumulco, *Steyermark 36553* (F). SANTA ROSA—Malpais, *Heyde & Lux 6071* (G, US). SOLOLA—Primavera, *Shannon 419* (US). ZACAPA—Zacapa, *Pittier 1749* (NY, US). DEPT. IN DOUBT—near Jacaltenanjo, *Nelson 3563* (US).

HONDURAS: ATLANTIDA—Tela, *Standley 52756, 54127* (A, F, US). COMAYAGUA—El Achote, *Yuncker, Dawson & Youse 5879* (F, G, M), *5880* (F), *6239* (F, G, M, NY). SANTA BARBARA—San Pedro Sula, *Thieme 5168* (US).

SALVADOR: SAN MIGUEL—Laguna de Olomega, *Standley 21021* (G, US). SAN SALVADOR—San Salvador, *Calderon 121* (F, G, M, NY, US), *Standley 22690* (G, NY, US); Volcan de San Salvador, *Standley 22975* (G, NY, US). SAN VICENTE—San Vicente, *Standley 21402* (G, US). WITHOUT DEFINITE LOCALITY—*Renson 8* (US).

NICARAGUA: MANAGUA—Managua, *Artemio 72* (US), *Chaves 75* (US), *Garnier 291* (US), *Greenman 5665, 5712* (M), *Maxon, Harvey & Valentine 7275, 7353* (US), *7450* (NY, US); Momotombo, *Smith 118* (G, M, US). RIVAS—San Juan del Sur. *West 3552* (G, M).

COSTA RICA: ALAJUELA—Carrillos de Poas, *Brenes 19308* (F); San Ramon, *Brenes 17050, 21480, 21917* (F), *Tondus 17654* (US). CARTAGO—Cartago, *Biolley 8977* (US), *Cooper 54* (F), *Standley 33368* (US); Copey forest, *Tondus 11693* (F, US). SAN JOSE—Cerro de Escaso, *Solis 266* (F); San Jose, *Valerio 220* (F); Santa Maria de Dota, *Standley 42268* (US), *Tonduz 11631* (US). PROV. IN DOUBT—between Santiago and Picacho Mondongo, *Brenes 16967* (F); exact locality unknown, *Worthen* (M), *Valerio 67* (US).

WEST INDIES: BARBADOS—Lodge Hill, St. Michael, *Botanic Station 508* (NY, US). CUBA—Havana Botanical Garden, *Britton & Wilson 511* (NY), *Curtiss 726* (A, F, G, M, NY, US); Havana, *Leon 695* (NY); Olimpo Finca, *Hioram 3976* (NY); Oriente, *Ekman 10069* (NY); Santiago de las Vegas, *Baker 7* (A, G, M, NY, US). JAMAICA—Mount Pleasant, *Harris 11143* (F, NY, US); St. Andrew, *Harris 11835* (F, G, M, NY, US). VIRGIN ISLANDS—St. Thomas, *Northrop 8* (NY).

COLOMBIA: CUNDINAMARCA—Bogotá, *Triana 388, 3132* (US); El Colegio, *Aristé-Joseph 1060* (A, F, US); El Paso, *Arbelaez & Cuatrecasas 6565* (US); Girardot, *Rusby & Pennell 143* (NY), *170* (NY, US); Ibague, *Aristé-Joseph* (US). SANTANDER—Las Vegas, *Killip & Smith 16087* (G, US). SANTANDER DEL NORTE—Tapata, *Killip & Smith 20179* (G, US). TOLIMA—Honda, *Aristé-Joseph A975, s.n.* (US), *Holton 748* (G, NY).

VENEZUELA: DISTRITO FEDERAL—Caracas, *Pittier 7121* (G, NY, US), *11116* (A, G,

NY, US). MÉRIDA—Tabay, *Gehriger 565* (F, US). MIRANDA—San Diego de los Altos, *Pittier 13014* (A, F, NY, US).

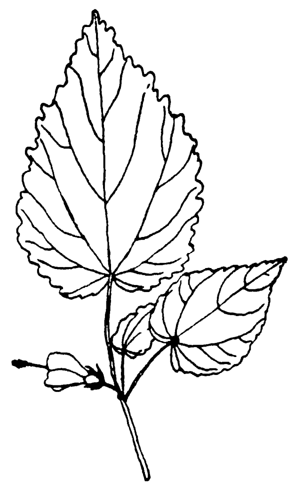
ECUADOR: CHIMBORAZO—Huigra, *Rose 22595* (US).

PERU: JUNIN—Chanchamayo Valley, *Schunke 21, 1492* (F); Juaja, *Univ. of Lima 13* (L); San Ramon, *Killip & Smith 24714* (F, NY, US), *Schunke A116* (F, US). LIMA—*Univ. of Lima 75* (L). LORETO—Balsapuerto, *Klug 3015* (A, F, G, M, US).

BRAZIL: AMAZONAS—mouth of Rio Embira, *Krukoff 5150* (A, F, NY, US).

This species shows an "influence" possibly derived from a cross with *M. candidus* in west-central Mexico some time ago and other later crosses with many varieties from Texas to South America. Thus it is a catch-all species for specimens approaching all the

M. arboreus var. *brihondus*
× approx. ⅛.



M. arboreus var. *cubensis*
× approx. ⅛.

varieties but differing in some way due to what may be termed the "candidus influence." This "candidus influence" may be manifest in either or both of two ways: (1) dense velvety pubescence of petioles, pedicels, upper branches, and lower leaf surface, or (2) distinctive lobation of the leaf towards the *M. candidus* type.

3a. Malvaviscus arboreus var. **brihondus**[23] Schery, n. var.

Shrub, upper branches pubescent, often scantily so, with appressed-stellate or straight hairs. Leaves oblong-lanceolate, 2.5–3.5 times as long as broad, unlobed, bluntly dentate to sinuate, sparsely pubescent on lower surface with large stellate hairs, upper surface with small appressed stellate hairs predominating over

[23] Frutex foliis oblongo-lanceolatis stellato-pubescentibus 2.5–3.5 plo longioribus quam latioribus; petiolis brevibus, 0.5–3.0 cm. longis; floribus parvis, 2.0–2.5 cm. longis.

straight hairs; petioles short, 0.5–3.0 cm., usually finely pubescent. Flowers very small, 2.0–2.5 cm. long. Involucral lobes usually wider toward the apex than toward the base. Mature staminal column exserted about half its length.

Distribution: British Honduras (see Map 2).

Specimens examined:

BRITISH HONDURAS: All Pines, *Schipp 708* (A, F, G, M, NY); Belize, *Lundell 4246* (F); Belize River, *Record* (G, US); El Cayo, *Gentle 2373* (A); Honey Camp, *Lundell 13, 52* (F), *480* (F, M TYPE, US), *Meyer 163* (F); Prospecto, *Gentle 870* (A, F, M, NY); Tower Hill Estate, *Karling 43* (F, US).

Distinguishing features of this variety are the small flower and the long, relatively narrow leaf which is generally short-petiolate and rounded at the base.

3b. Malvaviscus arboreus var. **cubensis** Schlecht. in Linnaea **11**: 360. 1837.

Malvaviscus Jordan-Mottii Millsp. in Field Col. Mus. Bot. **2**: 73. 1900.

Malvaviscus Cokeri Britton ex Coker in Shattuck, Bahama Isl. 259. 1905.

Woody shrub-like plants with upper branches, pedicels and petioles subglabrous or pubescent, usually with long (1.0–1.5 mm.) hairs. Leaves lanceolate to ovate-lanceolate, cordate or subcordate at the base, bluntly dentate to sinuate-margined, hairs preponderantly stellate on both upper and lower leaf-surfaces. Flowers very small, less than 2.3 cm. long. Involucral lobes linear or sublinear, densely or lightly pubescent. Mature staminal column exserted ½ to ⅓ its length.

Distribution: West Indies and occasional near the Yucatan Peninsula (see Map 2).

Specimens examined:

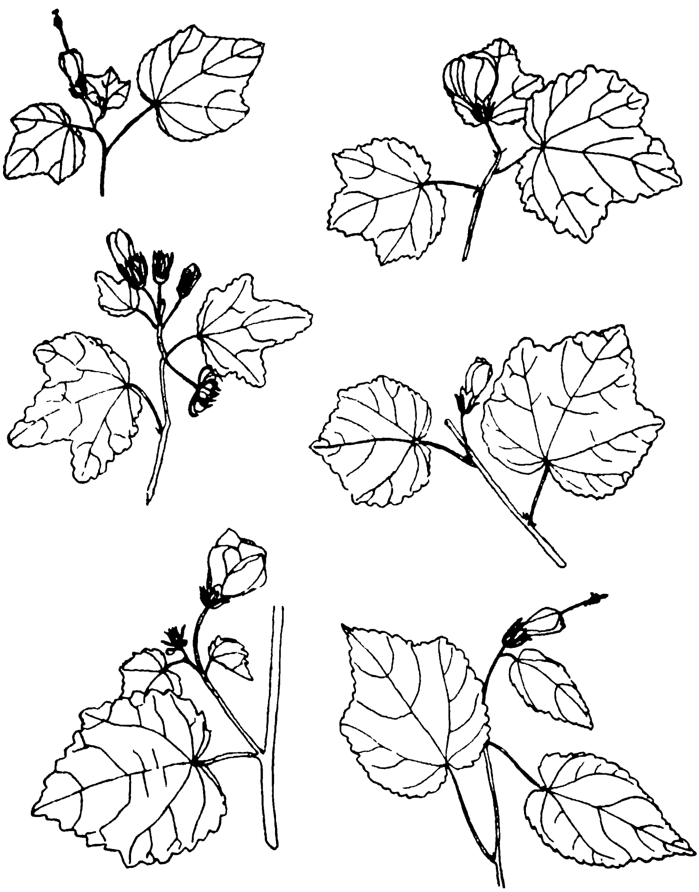
MEXICO: OAXACA—Tuxtepec, *Nelson 363* (US).

GUATEMALA: SACATEPEQUEZ—Acatenango, *Kellerman 4990* (US).

WEST INDIES: BAHAMA ISLANDS—Abaco: *Brace 1527* (A, F, US). Great Bahama: *Brace 3541* (F), *Britton & Millspaugh 2442* (F, G, US). Cayman Brac: The Creek, *Millspaugh 1166* (F). CUBA—Camarioca, *Britton & Wilson 14032* (NY, US); Cerro de Esperon, *Killip 13511* (US); Corrientes Bay, *Britton & Cowell 9902* (G, US); Guanajay, *Baker & Van Hermann 4253* (NY), *Palmer & Riley 697* (NY); San Juan Valley, *Roig 3160* (NY); without exact locality, *Wright 2064* (G, M). GRAND CAYMAN—Spot Bay, *Millspaugh 1313* (F); without exact locality, *Hitchcock* (F, M), *Rothrock 180, 237* (F). ISLE OF PINES—Boqueron, *Britton, Wilson & Selby 14498* (US). JAMAICA—Porus, *Lloyd 1108* (F, M); without exact locality, *Hart* (F).

This variety is close to var. *brihondus* from which it can be distinguished most easily by the broader, generally cordate leaf. It is distinguished from var. *mexicanus* and other varieties by the very small flowers.

3c. Malvaviscus arboreus var. **Drummondii** (Torr. & Gray) Schery, n. comb.



M. arboreus var. *Drummondii*, × approx. ⅓.

Malvaviscus Drummondii Torr. & Gray, Fl. N. Am. **1**: 230. 1838; Eaton & Wright, N. Am. Bot. 314. 1840; Engelm. & Gray in Boston Jour. Nat. Hist. (Pl. Lindh.) **5**: 6. 1845; Gray, Gen. Pl. U. S. **2**: 78, *pl. 131.* 1849; Gray in Smithson. Contr. to Knowledge (Pl. Wright.) **3**: 22. 1852; Torrey, Bot. Mex. Bound. Surv. 40 1856; Wood, Class-book Bot. 269. 1865; Coulter in Contr. U. S. Nat. Herb. (Bot. W. Texas) **2**: 43. 1891; Standl. in Contr. U. S. Nat. Herb. **23**: 774.

1923; Small in Addisonia 15: 19, *pl. 490.* 1930; Man. Southeast. Fl. 854. 1933.

Pavonia Drummondii Torr. & Gray, Fl. N. Am. 1: 682. 1840, fide S. Wats. loc. cit. 139. 1878; Walp. Rep. 1: 298. 1842; Dietr. Syn. Pl. 4: 824. 1847; Gray, Gen. Pl. U. S. 2: 76. 1849.

Hibiscus Drummondii Young, Fl. Texas, 186. 1873, fide S. Wats. Bibl. Ind. 139. 1878.

Procumbent, clambering or erect shrub; stems glabrous toward the base, densely and minutely tomentose apically, with tomentum uniform, of stellate or substellate hairs. Leaves cordate at base, as broad as long, shortly 3-lobed, bluntly dentate, usually with 5 prominent palmate veins, lower surface with many small stellate hairs and less abundant larger ones, upper surface predominantly straight-haired. Flowers small, usually 2.5–3.0 cm. long. Involucral lobes oblanceolate, widest above the middle, obtuse or acute apically. Mature staminal column exserted ½–¼ its length.

Distribution: Gulf states of the United States; eastern Mexico; evidently introduced into Cuba (see Map 2).

Specimens examined:

UNITED STATES: FLORIDA—Duval Co.: Jacksonville, *Curtiss* (G); Escambia Co.: Pensacola, *McCormick* (G); Hillsborough Co.: without exact locality, *Fredholm 6413* (G); Leon Co.: Tallahassee, *Berg* (NY). LOUISIANA—without exact locality, *Chapman* (NY). MISSISSIPPI—Adams Co.: Natchez, *Gale* (NY). TEXAS—Bexar Co.: Bracken, *Groth 209* (F, G, US); San Antonio, *Bush 1211* (M, NY, US), *Clemens 610* (M), *Dewey* (US), *Eggert* (M), *Havard* (US), *Heller 1833* (G, M, NY, US), *Jermy 191* (M), *271* (US), (M), *Metz* (NY), *Palmer 115* (G, M, US), *Reverchon 1197* (F, M, US), (F), *255518* (M), *Thurber* (G), *Ward* (US), *Wilkinson 47* (M), *102* (M, NY); Brazoria Co.: Brazoria, *Fisher 125* (US); Sandy Point, *Fisher 191* (US); Brazos Co.: College Station, *Palmer 10756* (M, US); Burnet Co.: Marble Falls, *Biltmore Herb. 11079a, 11079b* (US); Caldwell Co.: Columbia, *Bush 312* (M, NY); Cameron Co.: Brownsville, *Barber 23* (US), *Ferris & Duncan 3150* (M), *Pringle 1959* (F, G, M, NY, US), *Runyon* (M), *Townsend 49* (F, US), *Sargent* (A); Chambers Co.: Anahuac, *Hanson 2* (US); Comal Co.: New Braunfels, *Biltmore Herb. 11079e* (US), *Lindheimer 25* (F, G, M, US), *685* (F, G, M, NY, US), (M); Dallas Co.: Dallas, *Reverchon 1195* (F, US); Falls Co.: Gurley, *Howell 247* (US); Gillespie Co.: Fredericksburg, *Jermy 707* (M); Goliad Co.: Goliad, *Williams 70* (F, M); Harris Co.: Hockley, *Thurrow* (F); Houston, *Buckley* (M), *Hall 53* (F, G), *Mohr* (US), *Palmer 8584* (M, NY, US), *Ward* (US); Sheldon, *Reverchon 3827* (M); Hays Co.: San Marcos, *Trelease* (M), *Tharp* (NY); Jackson Co: Horseshoe Lake, without collector's name (M); Navidad River, *Drushel 2844* (M); Kendall Co.: Spanish Pass, *Clemens 609* (M, NY). Madison Co.: Trinity River, *Dixon 441* (F, G, NY); Montgomery Co.: Willis, *Warner* (M); Travis Co.: Austin, *Biltmore Herb. 11079c, 11079d* (US), *Letterman 66* (M, NY), *102* (M, US), *Bogusch 115* (A); Victoria Co.: Victoria, *Clark 3977* (M); Wharton Co.: Pierce, *Tracy 7476* (F, G, M, NY, US); Wharton, *Palmer 6609* (M, US); Williamson Co.: Round Rock, *Bodin 129* (US).

MEXICO: SAN LUIS POTOSI—Canoas, *Rose & Hough 4883* (US); Tancanhuitz, *Nelson*

4392 (US). TAMAULIPAS—El Milagro, *Bartlett 11069* (F, US); San Jose, *LeSueur 283* (F); Tampico, *Palmer 94* (G, M, NY, US), *387* (US), *525* (G, US).

WEST INDIES: CUBA—without exact locality, *Wright 2065* (M), *2068* (G, M, NY, US).

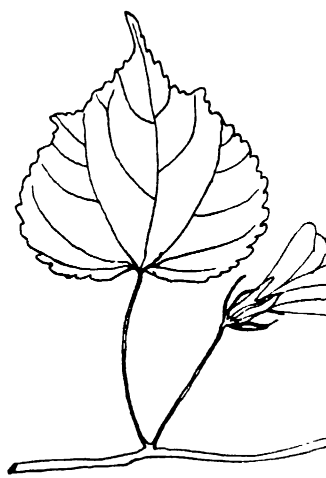
This is one of the most distinct varieties of *M. arboreus*. It is best distinguished by a combination of characters including the broad, cordate, obtusely lobed leaf; predominance of straight hairs on the upper leaf surface; and involucral lobes which are broadest above the middle.

3d. Malvaviscus arboreus var. **Hintoni** (Bullock) Schery, n. comb.

Malvaviscus Hintoni Bullock in Kew Bull. 291. 1937.

Shrub with upper branches, pedicels and petioles pubescent with long hairs (usually 1.0–1.5 mm. long). Leaves lanceolate, 2–3 times

M. arboreus var. *Hintoni* × approx. ⅓.



M. arboreus var. *longifolius* × approx. ⅛.

as long as broad, sometimes obscurely 3-lobed, rounded at base, bluntly serrate, lightly pubescent, lower surface with large stellate hairs, upper surface with smaller stellate and straight hairs. Flowers 3.5–5.0 cm. long, white or whitish. Involucral lobes linear or linear-spatulate. Mature staminal column exserted ⅓–¼ its length.

Distribution: east-central states of Mexico (see Map 2).

Specimens examined:

MEXICO: MEXICO—Temascaltepec, *Hinton 690* (F), *3928* (A, NY), *4289* (A, F, NY), *5057* (A, M, NY), *5371* (A, NY), *7912* (US). VERA CRUZ—Chontla, *Cardenas 375* (A, F).

This variety is very close to marginal types of *M. arboreus* and *M. arboreus* var. *mexicanus* but can be distinguished by the white

flowers (all other varieties have red flowers) and comparatively narrow lanceolate leaves.

3e. Malvaviscus arboreus var. **longifolius** (Garcke) Schery, n. comb.

Malvaviscus longifolius Garcke in Otto & Dietr. Allg. Gartenz. **22**: 321. 1854.

Malvaviscus cuspidatus Turcz. in Bull. Soc. Nat. Mosc. **31**: 190. 1858.

Malvaviscus leucocarpus Planch. & Linden ex Triana & Planch. in Ann. Sci. Nat. Bot., IV, **17**: 169. 1862; Mart. Fl. Bras. **12**^{3}: 536. 1892.

Malvaviscus Funkeanus Linden & Planch. Trois Voy. Linden in Pl. Columb. **1**: 41. 1863.

Malvaviscus elegans Linden & Planch. ex Mart. loc. cit. 537. 1892.

Malvaviscus maynensis Huber in Bol. Mus. Goeldi **4**: 583. 1906.

Malvaviscus integrifolius Ulbrich in Verhandl. Bot. Ver. Brandenburg **50**: 88. *fig. 2.* 1908.

Malvaviscus Ulei Ulbrich in Notizblatt **6**: 328. 1915.

Shrub-like plants with upper branches, pedicels and petioles usually with long (1.0–1.5 mm.) hairs, or glabrous. Mature leaves generally large (seldom less than 8 cm. long), ovate-lanceolate to triangular, usually cordate at the base, bluntly dentate or sinuate margined, entire or slightly lobed, upper surface variously pubescent, lower surface stellate-pubescent. Flowers large, usually longer than 4 cm. Involucral lobes linear or linear-lanceolate, usually narrow to acuminate-attenuate. Calyx long-cylindric, usually twice as long as broad or longer, often yellow-setose, contracted above and enclosing the fruit. Mature staminal column exserted ⅓–⅙ its length.

Distribution: northern South America (see Map 3).

Specimens examined:

COLOMBIA: ANTIOQUIA—Angostura?, *André K862* (F, G, NY). ATLANTICO—Barranquilla, *Elias 428* (US); Usiacuri, *Dugand 887* (F). BOLIVAR—Cartagena, *Heriberto 244* (US). WITHOUT EXACT LOCALITY—*Mutis 2262* (US).

VENEZUELA: DISTRITO FEDERAL—Caracas, *Allart 76* (NY, US); Cerro Avila, *Vogl. 76* (F); Los Flores a Papelon, *Delgado 271* (F, US), *Tamayo 385* (US). LARA—Barquisimeta, *Saer 65* (US). MÉRIDA—Tovar, *Fendler 101* (G, M).

ECUADOR: ORO—Santa Rosa, *Hitchcock 21141* (NY, US).

PERU: AYACUCHO—Estrella, *Killip & Smith 23065* (F, G, NY, US). JUNIN—Puerto Bermudez, *Killip & Smith 26648* (NY, US). LORETO—Iquitos, *Williams 8068* (F); La Victoria, *Williams 2675* (F); Rio Nanay, *Williams 508* (F). SAN MARTIN—Juan Jui, *Klug 3919* (F, G, M, NY, US), *4382* (A, F, M, NY, US).

BRAZIL: AMAZONAS—Manariao, *Krukoff 4589* (A, F, M, NY, US); Seringal (Rio Acre), *Ule 9591* (US).

This variety approaches *M. arboreus* and *M. arboreus* var. *penduliflorus,* on the one hand, and *M. arboreus* var. *Williamsii,* on the other. It can best be distinguished by the very long-cylindric calyx enclosing the fruit, the linear or linear-lanceolate involucral lobes, and the relatively large, broad leaves.

3f. Malvaviscus arboreus var. **mexicanus** Schlecht. in Linnaea **11**: 359. 1837, as *Mexicana;* E. G. Baker in Jour. Bot. **37**: 346. 1899.

Pavonia spiralis Cav. Ic. **5**: 20, *pl. 434.* 1799.

Malvaviscus grandiflorus HBK. Nov. Gen. & Sp. **5**: 286. 1821 [1822]; Standl. in Contr. U. S. Nat. Herb. **23**: 775. 1923.

Malvaviscus ciliatus DC. Prodr. **1**: 445. 1824.

Malvaviscus pentacarpus Moc. & Sessé ex. DC. loc. cit. 1824; ex. A. DC. Calq. des Dess. *pl. 88.* 1874.

Achania ciliata Spreng. Syst. Veg. **3**: 100. 1826.

Malvaviscus brevipes Benth. Bot. Voy. Sulph. 68. 1844.

Malvaviscus pulvinatus A. Rich. Bot.—Pl. Vasc., in Sagra, Hist. Nat. Cuba, 133. 1845 (?).

Malvaviscus Sagraeanus, A. Rich. loc. cit. 131, *pl. 14.* 1845(?).

Malvaviscus Guerkeanus Hieron. in Engl. Bot. Jahrb. **21**: 320. 1895.

Malvaviscus arboreus var. *Grisebachii* E. G. Baker in Jour. Bot. **37**: 345. 1899.

Malvaviscus arboreus var. *Sagraeanus* (Rich.) Baker, loc. cit. 1899.

Malvaviscus arboreus var. *Sloanei* Baker, loc. cit. 1899.

Malvaviscus brevibracteatus Baker, loc. cit. 347. 1899.

Malvaviscus Polakowskyi Baker, loc. cit. 346. 1899.

Malvaviscus rivularis Brandg. in Zoe **5**: 211. 1905; Standl. in Contr. U. S. Nat. Herb. **23**: 774. 1923.

Malvaviscus oaxacanus Standl. loc. cit. 775. 1923.

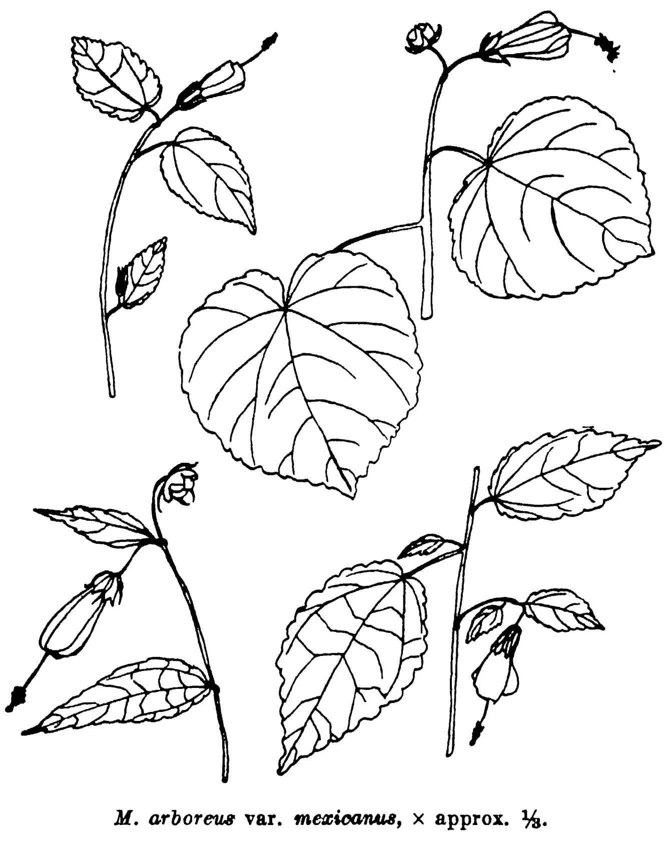
Bushy or vine-like shrubs, with upper branches, pedicels, and petioles variously pubescent or subglabrous. Leaves lanceolate or ovate-lanceolate, rounded or cordate at base, acute or attenuate at apex, serrate to sinuate-margined, unlobed or occasionally with slight marginal projections, variously pubescent. Flower of medium size, 2.3–4.2 cm. long. Involucral lobes linear or sublinear. Calyx campanulate-cylindric, somewhat longer than broad, glabrous or pubescent. Mature staminal column exserted ½–⅓ its length.

Distribution: southernmost United States to Panama; West Indies (see Map 5).

Specimens examined:

UNITED STATES: TEXAS—Cameron Co.: Brownsville, *Hanson* (M), *Rose & Russell 24292* (US).

MEXICO: CHIAPAS—Escuintla, *Matuda 2153* (F, NY); Tumbala, *Nelson 3346* (NY, US). COLIMA—Manzanillo, *Ferris 6078, 6231* (US), *Palmer 963* (G, US); Paso del Rio, *Emrick 167* (F). GUERRERO—Acapulco, *MacDaniels 191* (F), *Palmer 536* (G, US);



M. arboreus var. *mexicanus*, × approx. ⅓.

Galeana, *Hinton 10897* (M, NY, US); Mina, *Hinton 9597* (A, F, M, US); San Luis, *Langlasse 924* (G, US). JALISCO—Tuxpan, *Mexia 1023* (A, F, M, NY, US). MEXICO—Temascaltepec, *Hinton 4563* (A, NY), *5254* (A, NY, US), *Hinton 6719* (A, F, NY, US). MICHOACAN—Morelia, *Arsène 2729* (A, G, M, US). MORELOS—Cuernavaca, *Pringle 9662* (G, US), *Rose, Painter & Rose 10220* (US). NAYARIT—San Blas, *Ferris 5436* (A, US), *Wright 1348* (F, M); Tepic, *Palmer 1955* (F, G, NY, US). OAXACA—Ejutla, *Consatti 3948* (US); Jamiltepec, *Consatti 4430* (US); Oaxaca City, *Rose & Hough 4587* (US); Oaxaca Valley, *Nelson 1223, 1256* (G, US), *Pringle 4923* (A, F, G, M, NY, US), *Smith 296* (G), *638* (M); Tuxtepec, *Nelson 348* (US); Ubero, *Williams 9189, 9219* (F). PUEBLA—Huanchinango, *Goldman 22* (G, US); Puebla, *Arsène 128, 389, 1957* (US). SAN LUIS POTOSI—Espinazo del Diablo, *Pennell 17975* (US); Rio Tampaon, *Chase 7481*

(F, G); Tamazunchale, *Edwards 482* (F, M). SINALOA—Balboa, *Ortega 5116* (US); Culiacan, *Brandegee* (G, US). TAMAULIPAS—Tampico, *Kenoyer 772* (F), *s.n.* (M). VERA CRUZ—Catemaco, *Nelson 405* (US); Coatzacoalcos, *Smith 1023, 1030* (G, US), *1030* (M); Fortuno, *Williams 8336* (F); Jalapa, *Plunkett 140* (F); Vera Cruz, *Greenman 49* (F, G, NY); without exact locality, *Orcutt 2899* (F). YUCATAN—Chichankanab, *Gaumer 1858* (F, G, M, US), *Gaumer & sons 23686* (M); Chichen Itza, *Seler 4913* (G, US), *Steere 1127, 1618, 1642* (F); Izamal, *Gaumer* (F, US), *Greenman 443* (F, G, NY); Kancabonot, *Gaumer & sons 23523* (F, G, M, US); Merida, *Schott 177* (F), *s.n.* (F, US); Progresso, *Schott 271* (F, US), *Millspaugh 1728* (F); Silam, *Gaumer* (F); Suitun, *Gaumer & sons 23361* (A, F, G, M, NY, US); exact locality unknown, *Gaumer 580* (A, F, G, M, NY, US), *Goldman 579* (US); *Millspaugh 42* (F, US), *60* (F). STATE IN DOUBT —Miramar, *Matuda 93* (US); without locality, *Berlandier 566* (US).

BRITISH HONDURAS: Corozal, *Gentle 208* (F, US), [*Lundell 4890*] (F, M).

GUATEMALA: ALTA VERA PAZ—Coban, *Tuerckheim II607* (US); Pansamala, *Tuerckheim* (F, G, US); Tactic, *Standley 90542* (M). BAJA VERA PAZ—Santa Rosa, *Standley 69853* (F), *Tuerckheim II2312* (G, US). CHIQUIMULA—Jocotan, *Steyermark 31634, 31635* (F). ESCUINTLA—El Baul, *Rojas & Tonduz 56* (US); Escuintla, *Smith 1991* (G, US), *Standley 63420, 63919* (F), *89189, 89488, 89571* (F, M); Peinha, *Pittier 1793* (US); Rio Guacalate, *Standley 58277, 60179* (F); San Jose, *Standley 64000* (F). GUATEMALA—Chilloui, *Rojos 67* (G, US); Guatemala, *Ruano 405* (US), *Tonduz 814* (US). HUEHUETENANGO—Canibal, *Shannon 307* (US). IZABAL—Quirigua, *Standley 23857* (G, NY, US). JUTIAPA—Trapiche Vargas, *Steyermark 31790* (F). PETEN—La Libertad, *Aguilar 87* (A, M). QUEZALTENANGO—Palmar, *Kellerman 5811* (US); Los Positos, *Standley 67884* (F); Volcan Santa Maria, *Steyermark 33581* (F). RETALHULEU—Ajaxa, *Standley 88240* (F, M); Las Delicias, *Standley 88014, 88119* (F, M); Nueva Linda, *Standley 66536, 66539* (F); Retalhuleu, *Standley 66702, 66719, 66775* (F), *88262* (F, M); San Felipe, *Holway 694* (US). SACATEPEQUEZ—Antigua, *Standley 60322* (F); Volcan Acatenango, *Kellerman 4806* (US); Volcan de Agua, *Standley 59465* (F). SAN MARCOS —Ocos, *Steyermark 37878* (F); Tajumulco, *Steyermark 36665* (F). SANTA ROSA— Barberena, *Standley 77752* (F, M); Cuazacapan, *Standley 78616, 78644* (F, M); La Sepultura, *Standley 79410* (F, M); Taxisco, *Standley 79019* (F, M). SUCHITEPEQUEZ —Las Animas, *Shannon 384* (US); Mazatenango, *Holway 529* (US), *Kellerman 4962* (US), *Maxon & Hay 3470* (US); Patulul, *Standley 62146* (A, F). ZACAPA—Sierra de las Minas, *Steyermark 29878* (F); Zacapa, *Deam 161* (G, NY, US), *Kellerman 9019* (F), *Standley 72026* (F), *74212* (F, M).

HONDURAS: ATLANTIDA—Tela, *Standley 55780* (F, US). COMAYAGUA—Siguatepeque, *Yuncker, Dawson & Youse 5680* (F, G, M). YORO—Pijol, *C. & W. von Hagen 1104* (F, NY). WITHOUT EXACT LOCALITY—La Lima, *Johansen 29* (F).

SALVADOR: AHUACHAPAN—Ahuachapan, *Standley 19718a, 19855* (G, NY, US); without exact locality, *Padilla 193* (US), *197* (A, M, US). LA UNION—La Union, *Standley 20809* (G, US). SONSONATE—Armenia, *Standley 23520* (G, US); Finca Chilata, *Standley 19339* (G, NY, US); Izalco, *Standley 21837* (G, NY, US); Sonsonate, *Standley 22300* (G, NY, US).

NICARAGUA: MASAYA—Masaya, *Baker 163* (G, M, NY), *618* (US). DEPT. IN DOUBT— Braggman's Bluff, *Englesing 75, 94* (F); without exact locality, *Wright* (G, M, US).

COSTA RICA: CARTAGO—Carpintera Mt., *Stork 333* (US); Cartago, *Cooper 5719* (F, US); San Rafael, *Pittier 9030* (US). GUANACASTE—Cruz de Guanacaste, *Pittier 2770* (US); Hacienda Santa Maria, *Dodge & Thomas 6324* (M); Los Conventillos, *Tonduz 2884* (US); Nicoya, *Cooper 10367* (US), *Tonduz 13485* (G, M). PUNTARENAS—Santo Domingo del Golfo Dulce, *Tonduz 6982* (US). SAN JOSE—Guadaloupe, *Greenman 5433* (M); La Verbena, *Standley 32230* (US), *Tonduz 8946* (US); San Jose, *Tonduz 1092* (US). PROVINCE IN DOUBT: Ochonogo, *Pittier 59* (US).

PANAMA: CHIRIQUÍ—Bajo Mona, *Woodson & Schery 531* (M); Boquete, *Pittier 2985, 3138* (US); Pena Blanca, *Woodson & Schery 302* (M); Quebrada Velo, *Woodson & Schery 276* (M); New Switzerland, *Allen 1364* (F, G, M, NY); Peninsula de Burica, *Woodson & Schery 932* (M). COCLÉ—El Valle, *Allen 91* (A, G, M), *1176* (F, M) *P. & G. White 70* (G, M). DARIEN—Tucuti, *M. E. & R. A. Terry 1386* (M). PANAMÁ—Taboga Island, *Standley 27924* (US). VERAGUAS—Sona, *Allen 1045* (F, G, M).

WEST INDIES: BAHAMAS—Watlings Island, *Britton & Millspaugh 6145* (US). CUBA—Havana, *Britton & Wilson 4535* (F); Oriente, *Ekman 2976* (F); Pinar del Rio, *Palmer & Riley 597* (US), *van Hermann 253* (F, NY), *Wilson & Leon 11297* (US); Sierra de Omafe, *Leon 4745* (NY). JAMAICA—Blue Mountain Peak, *Hitchcock* (M); Cinchona, *Harris & Lawrence C15297* (US), *Marble 193* (NY), *Rehder* (A); Diabolo Mt., *Maxon & Killip 398* (US); Gordon Town, *Hart 571* (US); John Crow Mts., *Britton 3995* (NY); Latimer River, *Nichols 63* (NY, US); Lucea, *Britton 2917* (NY); Mandeville, *Britton 999* (NY); *Brown 78* (NY); Negril, *Britton & Hollick 2093* (NY); Port Antonio, *Hitchcock* (F, M), *Millspaugh 931* (F, NY), *Wight 22* (F, NY); Rio Grande, *Millspaugh 1920* (F); Walderston, *Harris 12863* (F, G, M, NY, US); Wavels Rock, *Fawcett 8022* (NY); without exact locality, *Alexander* (M). TRINIDAD—Queen's Royal College grounds, *Broadway 7690* (F, M); St. Ann's, *Broadway 7324* (NY).

COLOMBIA: ANTIOQUIA—San Geronimo, *Tomas 622* (US). ATLANTICO—Barranquilla, *Elias 655* (US). BOYACA—Uvita, *Cuatrecasas 1850* (US). CUNDINAMARCA—San Javier, *Aristé-Joseph* (US); Tabio, *Antonio 16E* (US). MAGDALENA—Aracataca, *Dugand & Barriga 2476* (US). SANTANDER—Badillo, *Pennell 3910* (NY, US).

The only character which separates this variety from varieties *penduliflorus* and *cubensis* is the flower size. Admittedly arbitrary limits are given for flower size, but this is necessary in view of the fact that complete intergradation occurs between these varieties. Here the flower is smaller and less robust than in var. *penduliflorus*, with the mature staminal column, as a rule, more exserted. On the other hand, the flowers are not as dwarfed as in var. *cubensis* and the staminal column is usually less exserted.

3g. Malvaviscus arboreus var. **palmanus** (Pittier & D. Smith) Schery, n. comb.

Malvaviscus palmanus Pittier & D. Smith in Bot. Gaz. **23**: 238. 1897.

Shrub or vine-like plants with upper branches, pedicels, and petioles generally thickly pubescent with short stellate hairs, sometimes also with longer straight hairs, or almost glabrous. Leaves entire, almost symmetrically elliptic, broadest at the middle, usually large when mature (as long as 20 cm. in extreme cases), 2 to 4 times as long as broad, with 3 prominent palmate veins from which smaller reticulate veins emerge almost at right-angles, stellate-pubescent on both surfaces; margins shallowly dentate or sinuate. Flowers large, usually 4–5 cm. long. Involucral lobes essentially linear. Mature staminal column exserted ⅓–⅕ its length.

Distribution: Costa Rica (see Map 2).

Specimens examined:

COSTA RICA: ALAJUELA—La Ventolera, *Standley 34685* (US); San Carlos, *Smith H1670* (F, M); San Ramon, *Brenes 5954, 13418, 21969, 21982, 22623* (F); Viento Fresco, *Standley & Torres 47926* (US); CARTAGO: Orosi, *Standley 39640, 39837* (US). GUANACASTE—El Silencio, *Valerio 66* (US); Tilaran, *Brenes 15630* (F), *Standley & Valerio 44605, 46238* (US). HEREDIA—San Frideo, *Pittier 14015* (US); Vara Blanca de Sarapiqui, *Skutch 3266* (A, M). SAN JOSE—La Hondura, *Standley 36585* (US); La Palma, *Maxon & Harvey 8004* (US), *Standley 33209* (US), *Stevens 301* (US), *Tonduz 7393* (F, G, M, US), *8089, 12465* (NY, US); PROVINCE IN DOUBT: Zarcero, *Smith H20* (F, M), *A316* (F); without exact locality, *Smith? 7393* (M).

M. arboreus var. *palmanus*, × approx. 1/3.

This variety approaches vars. *penduliflorus* and *mexicanus* but can be distinguished by its almost perfectly elliptic leaves.

3h. Malvaviscus arboreus var. **penduliflorus** (DC.) Schery, n. comb.

Malvaviscus penduliflorus Moc. & Sessé ex DC. Prodr. **1**: 445. 1824; ex A. DC. Calq. des Dess. *pl. 90.* 1874; Standl. in Contr. U. S. Nat. Herb. **23**: 774. 1923.

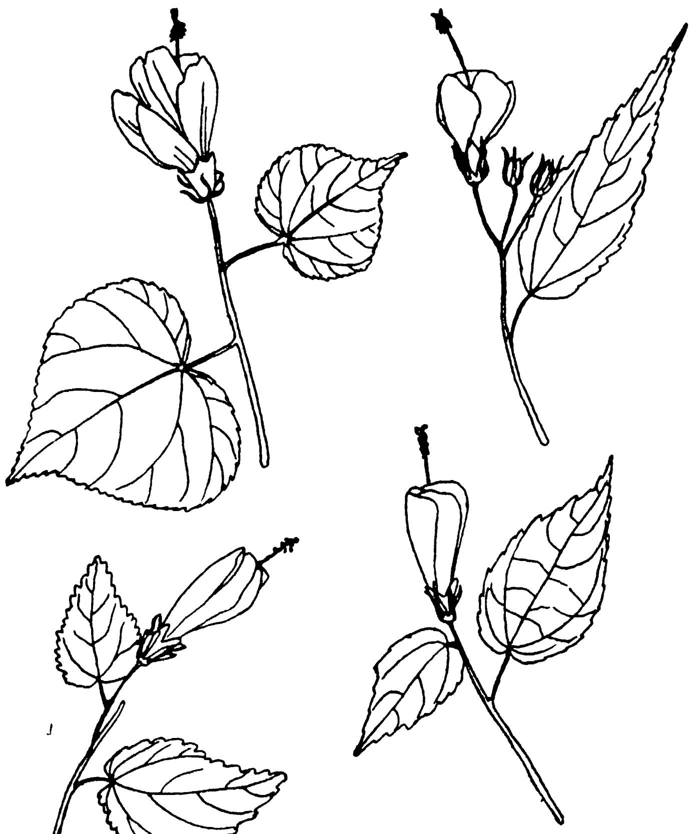
Malvaviscus oligotrichus Turcz. in Bull. Soc. Nat. Mosc. **31**: 190. 1858.

Malvaviscus glabrescens Planch. & Lind. ex Triana & Planch. in Ann. Sci. Nat. Bot. IV, **17**: 168. 1862, nomen nudum in synon. (= *M. oligotrichus* fide Triana & Planch.).

Malvaviscus lanceolata Rose in Contr. U. S. Nat. Herb. **5**: 175. 1899.

Malvaviscus Conzattii Greenm. in Field Col. Mus. Bot. **2**: 333. 1912; Standl. in Contr. U. S. Nat. Herb. **23**: 774. 1923.

Bushy or vine-like shrubs; upper branches, pedicels, and petioles with long (1.0–1.5 mm.) hairs, or glabrous. Leaves lanceolate or ovate-lanceolate, rounded or cordate at base, acute or attenuate at apex, serrate to sinuate-margined, variously pubescent. Flower robust, longer than 4.2 cm., often appearing abruptly truncate at



M. arboreus var. *penduliformis*, × approx. ⅓.

the tip in herbarium specimens. Involucral lobes essentially linear in southern part of plant range, often broader and more or less spatulate in northern part. Calyx more or less cylindric, somewhat longer than broad, glabrous or lightly haired. Mature staminal column exserted ⅓–¼ its length.

Distribution: widespread, from central Mexico to Colombia (see Map 4).

Specimens examined:

MEXICO: CHIAPAS—Chicharras, *Nelson 3807* (G, US); La Illusion, *Mell 2019* (US); San Cristobal, *Nelson 3170* (US). GUERRERO—Chilacayote, *Hinton 14181* (G); Petlacala,

Mexia 9094 (G, M, NY); Pilas Pasion Filo Mayor, *Hinton 10753* (F, M, US); Plan de Carrizo, *Hinton 11030* (G); San Marcos, *Nelson 2264* (US); Sierra Madre, *Langlasse 793* (G, US). JALISCO—Puerto Vallarta, *Mexia 1135* (A, F, M, NY, US); Santa Cruz de Vallarta, *Mexia 1267* (US); San Sebastian, *Mexia 1442* (A, F, G, M, NY, US). MEXICO—Temascaltepec, *Hinton 4014* (A, NY, US). MICHOACAN—Zitacuaro, *Hinton 13529* (G). MORELOS—Cuernavaca, *MacDaniels 305* (F), *Rose & Hough 4351* (US). OAXACA—Cafetal Concordia, *Morton & Makrinius 2391* (F, US), *Reko 3348* (US); Comaltepec, *Nelson 926* (US); Plunia, *Nelson 2500* (NY, US); San Pablo Huitzo, *Conzatti 1981* (F); Santo Domingo, *Conzatti 1683* (F, US); Yaveo, *Mexia 9204* (G, M, NY). PUEBLA—Piaxtla, *Nelson 2016* (US). QUERETARO—Cerro de las Campañas, *Arsène 10058* (F, M, US); without exact locality, *Agniel 10525* (A, F, G, M, US). SINALOA—without further locality, *Ortega 7327* (F). VERA CRUZ—Cordoba, *Schery 188* (M); Tampico, *Palmer 391* (M, NY, US). STATE IN DOUBT—from Mexican seed, *Rose 4027* (US).

GUATEMALA: ALTA VERA PAZ—Panzos, *Maxon & Hay 3080* (US); Saxoc, *Tuerckheim 8185* (US). BAJA VERA PAZ—Paujal, *Tuerckheim II1721* (US). CHIMALTENANGO—Quisache, *Standley 62039* (A, F), *62048* (F). IZABAL—Boca del Polochic, *Smith 1658a* (US); Quirigua, *Standley 24587* (G, NY, US), *72311* (F). QUEZALTENANGO—Aguas Amargas, *Standley 65416* (F); Chiquihuite, *Standley 68102, 68112* (F); Santa Maria de Jesus, *Standley 68236* (F, NY), *Steyermark 33386* (F); Volcan Zunil, *Skutch 878* (A, F). RETALHULEU—San Felipe, *Steyermark 34516* (F). SOLOLA—Volcan Atitlan, *Hatch & Wilson 360* (F).

HONDURAS: ATLANTIDA—La Ceiba, *Yuncker, Koepper & Wagner 8523* (F, M, NY); Tela, *Mitchell 131* (F, G), *Standley 53743* (A, F, US), *54021* (F), *54786* (A, F, US). SANTA BARBARA—San Pedro Sula, *Bangham 341* (A), *Thieme 5153* (G, NY, US). YORO—Guaymas district, *Standley 55493* (A, F, US); Quebrada Seca, *Standley 53926* (A, F, US); Progresso, *Standley 54987* (A, F, US). DEPT. IN DOUBT—Puerto Sierra, *Wilson 42* (NY, US).

NICARAGUA: ATAGALPA—Jinotega, *Grant 7298* (A).

COSTA RICA: ALAJUELA—Capulin, *Standley 40163* (US); Naranjo, *Stork 1828* (F); Palmira, *Smith 4215* (F); San Pedro, *Brenes 16998* (F). CARTAGO—Cartago, *Holway 276* (US), *Standley & Valerio 49600* (US), *Stork 2834* (F); Cerro Carpintera, *Dodge & Thomas 4784* (M), *Standley 35756* (US); Irazu Volcano?, *Pittier 13063* (US). GUANACASTE—Culebra Bay, *Pittier 12020* (US). HEREDIA—Puerto Viejo & Sarapiqui River, *Biolley 7403* (US); Santo Domingo del Roble, *Dodge & Goerger 9582* (F, M). LIMON—La Colombiana farm of United Fruit Co., *Standley 36978* (US). SAN JOSE—El General, *Skutch 2368* (A, G, M, NY, US); San Francisco de Guadalupe, *Pittier 13031* (US), *Tonduz 6973* (G, US); San Jose, *Biolley 43* (F), *Holway 402* (US), *Tonduz 7260* (US); Santa Maria de Dota, *Standley 41845* (F, US), *Standley & Valerio 43278* (F, US), *Stork 2975* (F); Tucurrique on Las Vueltas River, *Tonduz 13149* (US); Ciruelas River, *Tonduz 2218* (US); San Isidro Coronado, *Alfaro 32378* (F, US); Llanuras de Santa Clara, *Smith 6450* (US).

PANAMA: BOCAS DEL TORO—Almirante, *Cooper & Slater 26* (US), *Cooper 103* (F, NY); Bocas del Toro?, *Carleton 81* (NY, US); Changuinola River, *Dunlap 101* (F), *349* (F, G, US), *440* (F). CHIRIQUÍ—Bajo Chorro, *Davidson 68* (A, F, M); Bajo Mona, *Woodson & Schery 550* (M); Boquete, *Maxon 5000* (US); Cerro Punta, *Seibert 263* (A, M, NY); San Felix, *Pittier 5210* (NY, US). COCLÉ—El Valle, *Allen 1906* (M), *Woodson & Schery 188* (M). PANAMÁ—Rio la Maestra, *Allen 52* (A, G). PROVINCE IN DOUBT—western Panama, *Stork 101* (US).

COLOMBIA: BOLIVAR—Cartagena, *Killip & Smith 14052* (A, G, NY, US); Turbaco, *Killip & Smith 14187* (G, US). CAQUETA—Cordillera Oriental, *Cuatrecasas 9153* (US). MAGDALENA—Santa Marta, *Smith 492* (NY), *734* (A, F, G, M, NY, US), *735* (F, G, M, NY, US), *2727* (G, NY), *2816* (NY). SANTANDER—Barranca Bermeja, *Haught*

1532 (F, US); California, *Killip & Smith 16890* (G, US). DEPT. IN DOUBT—Fouinne?, *Arbelaez 2456* (US).

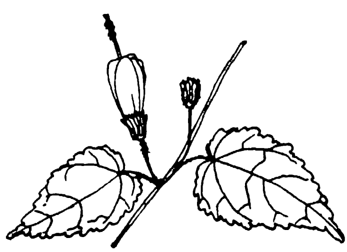
VENEZUELA: DISTRITO FEDERAL—Cerros del Avila, *Pittier 49* (NY, US); Galipan, *Pittier 83* (NY, US).

ECUADOR: PROVINCE IN DOUBT—La Chonta, *Rose, Pachano & Rose 23478* (NY, US).

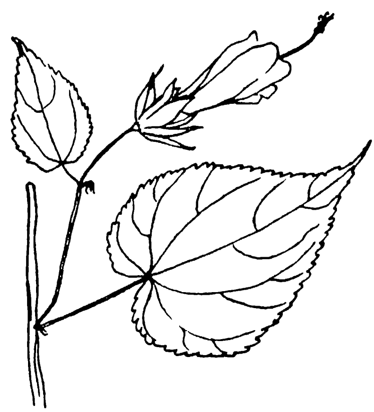
This variety shows complete intergradation with var. *mexicanus* from which it must be separated rather arbitrarily. The difference between these varieties is in the flower, var. *penduliflorus* having a more robust flower, almost always greater in length than the arbitrary limit of 4.2 cm.

3i. **Malvaviscus arboreus** var. **sepium** (Schlecht.) Schery, n. comb.

Malvaviscus sepium Schlecht. in Linnaea **11**: 361. 1837; Standl. in Contr. U. S. Nat. Herb. **23**: 775. 1923, as syn.



M. arboreus var. *sepium* × approx. ⅛.



M. arboreus var. *Williamsii* × approx. ⅛.

Shrub with upper branches, pedicels, and petioles lightly or thickly pubescent with long (1.0–1.5 mm.) hairs, pubescence usually decurrent in ridges on petiole and stem. Leaves small (less than 10 cm. long, usually about 6 cm.), 1.5–3.5 times as long as broad, lanceolate to ovate-lanceolate, bluntly dentate, unlobed, upper leaf-surface predominantly straight-haired, lower surface with few to many straight hairs interspersed among stellate hairs. Flower small, 2.0–3.2 cm. long. Involucral lobes spatulate. Mature staminal column exserted ½–⅓ its length.

Distribution: Vera Cruz and occasional elsewhere in northeastern Mexico (see Map 2).

Specimens examined:

MEXICO: NUEVO LEON—Monterrey, *collectors unkonwn* (F, US). VERA CRUZ—Cordoba, *Bourgeau 1512, 1669* (G, US), *Greenman 191* (F, G); Coscomatepec, *Matuda 1310*

(F); Fortin, *Fisher 35506* (F); Jalapa, *Barnes, Chamberlain & Land 34* (F), *MacDaniels 944* (F), *Orcutt 2811* (F, M), *Plunkett 45* (F), *Pringle 7833* (G, US), *8202* (A, F, G, M, NY, US), *Rose & Hay 6184* (NY, US), *Rose & Hough 4245* (US); Mirador, *Mohr* (US); Nogales, *Seaton 300* (F, G, US); Orizaba, *Fisher 152* (US, F, M), *Mohr* (US), *Pringle 5914* (US); Azcuapan, *Purpus 7430* (G, M, US), *10729* (US).

This variety is close to var. *mexicanus* and is best distinguished by the spatulate involucral lobes, the small flowers and leaves, and the predominantly straight-haired pubescence of the upper leaf surface.

3j. Malvaviscus arboreus var. **Williamsii** (Ulbrich) Schery, n. comb.

Malvaviscus Williamsii Ulbrich in Notizblatt **11**: 545. 1932.

Shrub-like plant with upper branches, pedicels and petioles stellate-pubescent, often densely so. Leaves broadly lanceolate to triangular, cordate at base, unlobed or occasionally with small marginal projections, shallowly or deeply dentate, usually predominantly stellate-pubescent on both surfaces. Flowers large, 4–6 cm. long. Involucral lobes large, more or less foliaceous, lanceolate or ovate-lanceolate, 4–8 mm. broad near the base, more or less covering and concealing the long-cylindric, yellow-setose calyx. Mature staminal column exserted ⅓–⅙ its length.

Distribution: Peru and Colombia (see Map 3).

Specimens examined:

COLOMBIA: PUTUMAYO—Umbria, *Klug 1712* (F). DEPT. IN DOUBT—Tocamet, *Schott 3* (F).

PERU: LORETO—Florida, *Klug 2077* (A, F, G, M, NY, US); Gamitanacocha, *Schunke 293* (A, F, NY, US).

This variety is close to var. *longifolius* which it resembles especially in calyx and leaf characters. However, it is the only variety with large, broad involucral lobes.

PAVONIA Cav.

4. Pavonia firmiflora Schery, n. sp.

Frutex undique stellato-pubescens; foliis maturis subrotundis, magnis, ca. 14 cm. longis, 12 cm. latis, aliquid 3–5-lobatis lobis mediis prominentibus, profunde cordatis, subtus pallidioribus et pubescentioribus, 7–9 venis prominentibus palmatis; petiolis folia aequantibus vel longioribus; floribus terminalibus brevi-racemiformibus; pedicellis 0.5–6.0 cm. longis; involucris subpatelliformibus ca. 8–9-lobatis, stellato-pubescentissimis, lobis linearibus, acutis; calycibus 1.0–1.5 cm. diametro, extus stellato-pubescentibus,

intus brevi-mollissimis, 5-lobatis, lobis lanceolatis; petalis obovatis, inaequilateralibus, retusis, non-auriculatis, 3.5–4.0 cm. longis; tubis staminalibus non exsertis, columniformibus, supra medium in filamenta congesta monanthera divisis, apice nudis, dentatis; ovariis subglobosis, rigide pubescentissimis, 5-carpellatis, carpellis uniovulatis et monoseminatis; stylis 10; fructibus juventate rigide pubescentissimis; seminibus subreniformibus, glabris.

Distribution: Jalisco, Mexico (see Map 6).

Specimens examined:

MEXICO: JALISCO—Tequila, *Pringle 5447* (F, G, M TYPE, NY, US).

Pavonia firmiflora, × approx. ⅛.

The Pringle specimens have for almost 50 years been labeled in herbaria as "*Malvaviscus acerifolius* Presl. (ex. char.)." Only this collection *(Pringle 5447)* has ever been made of specimens referable to the new species, *P. firmiflora*. The specimens differ from those of the original description of *Malvaviscus acerifolius* especially in having stiffly pubescent fruit and a shortened staminal column. A comparison of *Pavonia firmiflora* with a photograph of the *M. acerifolius* type specimen shows *P. firmiflora* to have a coarser, stouter appearance and different leaf texture.

Pavonia firmiflora is close to *Pavonia Palmeri* (Baker) Schery (formerly *Malvaviscus Palmeri)*, but has much larger flowers, a condensed inflorescence, and only slightly lobed leaves. It is possible that *P. firmiflora* is a hybrid between *Pavonia Palmeri* and

perhaps *Malvaviscus candidus*. The fact that only one collection has ever been made would tend to support this view.

The border-line between *Pavonia* and *Malvaviscus* is vague. It is difficult to tell where a fleshy fruit stops and a dry fruit begins, to use this classical character of demarcation between *Malvaviscus* and *Pavonia*. This is true of *Pavonia firmiflora;* yet *P. firmiflora* is so similar to *P. Palmeri* that inclusion in the genus *Pavonia* seems entirely warranted, especially since *P. firmiflora* does not have auriculate petals, an additional definite character of *Pavonia*, sug-

Pavonia Palmeri, × approx. ⅙.

gested in the introduction to this monograph for use in distinguishing between *Malvaviscus* and *Pavonia*.

The whole *P. firmiflora* plant has a coarse, dense, stellate pubescence. The cordate leaves are slightly lobate, a lighter gray color and more densely pubescent on the under side than above. The inflorescence is almost a condensed raceme, although occasional flowers are axillary in the upper leaves. The involucre is broad, with narrow linear-lanceolate lobes, shorter than the robust calyx. The calyx is minutely pannose within, with a circular bare area at the base surrounding the 5-carpellate densely haired ovary. There is one subreniform seed almost completely filling each carpel.

5. **Pavonia Palmeri** (Baker) Schery, n. comb.

Malvaviscus Palmeri Baker f. ex Rose in Contr. U. S. Nat. Herb. **3**: 313. 1895.

Malvaviscus cinereus Baker f. ex Robins. & Greenm. in Am. Jour. Sci. III, **50**: 176. 1895, nomen; E. G. Baker in Jour. Bot. **37**: 347. 1899.

Pavonia amplifolia Standl. in Pub. Field Mus. Bot. **4**: 230. 1929.

Distribution: western Mexico (see Map 6).

Specimens examined:

MEXICO: JALISCO—San Sebastian, *Mexia 1480* (F, G, M), *Nelson 4061* (G, US). NAYARIT—Tepic, *Palmer 1835*, in part (F, G), *1990* (F, G, NY, US).

The transfer of this species from *Malvaviscus* to *Pavonia* is made on the basis of the general structure of flower and fruit. The petals are not auriculate and the fruit can scarcely be termed "fleshy."

EXCLUDED SPECIES

Malvaviscus cinereus Baker f. ex Rob. & Greenm. in Am. Jour. Sci. III, **50**: 176. 1895, nomen subnudum; E. G. Baker in Jour. Bot. **37**: 347. 1899 = **Pavonia Palmeri** (Baker) Schery.

Malvaviscus coccineus Medic. Malv. 49. 1787 = **Hibiscus coccineus** Walt., fide Ind. Kew., probably **Pavonia** sp.

Malvaviscus floridanus Nutt. in Jour. Acad. Phila. **7**: 89. 1834 = **Hibiscus Bancroftianus** Macfad., fide Ind. Kew.

Malvaviscus fragilis Bory ex DC. Prodr. **1**: 446. 1824, as syn. = **Hibiscus liliiflorus** Cav., fide Ind. Kew. *(H. fragilis* DC. loc. cit).

Malvaviscus longifolius Spach, Hist. Veg. Phan. **3**: 370. 1834 = **Pavonia longifolia** A. St. Hil., fide Ind. Kew.

Malvaviscus montanus Mart. ex Garcke, Jahrb. Bot. Gart. Berlin **1**: 222. 1881 = **Pavonia montana** Garcke, fide Ind. Kew.

Malvaviscus multiflorus Spach, loc. cit. 1834 = **Pavonia multiflora** A. St. Hil., fide Ind. Kew.

Malvaviscus Palmeri Baker f. ex Rose in Contr. U. S. Nat. Herb. **3**: 313. 1895 = **Pavonia Palmeri** (Baker) Schery (see above).

Malvaviscus populifolius Presl, Reliq. Haenk. **2**: 135. 1853 = **Hibiscus** sp., as judged from the description.

Malvaviscus populneus Gaertn. Fruct. **2**: 253, *pl. 135, fig. 3.* 1791 = **Thespesia populnea** Soland., fide Ind. Kew.

Malvaviscus puniceus Bory ex DC. loc. cit. 446. 1824, as syn. = **Hibiscus liliiflorus** Cav., fide Ind. Kew.

Malvaviscus rosa-sinensis Moench ex Steud. Nom. Bot. ed. 2. **1**: 760. 1841 = **Hibiscus rosa-sinensis** L., fide Steud.

SPECIES OF DOUBTFUL STATUS

Achania cordata Nees & Mart. in Nov. Act. Nat. Cur. **11**: 99. 1823, not *Malvaviscus*, probably *Pavonia*. Same as *Pavonia coccinea* Willd., fide Nees & Mart.

Achania floridana Raf. New Fl. N. Am. 1: 4. 1836? = **Hibiscus Bancroftianus** Macfad. *(H. floridanus* Shuttlew.), fide Ind. Kew.

Achania Poeppigii Spreng. Syst. **3**: 100. 1826 = **Hibiscus Poeppigii** Garcke, fide Ind. Kew. (see *Malvaviscus Poeppigii).*

Achania stylosa Schrank in Flora **2**: 449. 1819, nomen dubium.

Achania tomentosa Sterler ex Steud. Nom. Bot. ed. 2, **1**: 12. 1841, nomen nudum.

Anotea chlorantha (Malvaviscus chloranthus) Kth. ex Ulbrich in Fedde's Rep. Spec. Nov. **14**: 108. 1915, probably **Pavonia** sp. as judged from photograph of type and from the description.

Anotea flavida (DC.) Ulbrich, loc. cit. 109. 1915, genus and species doubtful, probably **Pavonia** sp.

Malvaviscus flavidus Moc. & Sessé ex DC. Prodr. **1**: 446. 1824, genus and species doubtful, probably **Pavonia** sp.

Malvaviscus pleurantherus Moc. & Sessé ex DC. loc. cit. 1824, genus and species doubtful.

Malvaviscus pleurogonus Moc. & Sessé ex DC. loc. cit. 1824, genus and species doubtful.

Malvaviscus Poeppigii (Spreng.) G. Don, Gen. Syst. Dichl. Pl. **1**: 475. 1831, nomen dubium = **Hibiscus Poeppigii** Garcke, fide Ind. Kew. Perhaps, were the description more complete and definitive, this name should be included as a synonym of **Malvaviscus arboreus** var. **mexicanus.**

INDEX TO SPECIMENS CITED

The number in italics refers to the collection number, the number in parentheses to the species or variety under which the specimen is cited: (1)—*M. candidus;* (3)—*M. arboreus;* (3a)—var. *brihondus;* (3b)—var. *cubensis;* (3c)—var. *Drummondii;* (3d)—var. *Hintoni;* (3e)—var. *longifolius;* (3f)—var. *mexicanus;* (3g)—var. *palmanus;* (3h)—var. *penduliflorus;* (3i)—var. *sepium;* (3j)—var. *Williamsii;* (4)—*P. firmiflora;* (5)—*P. Palmeri.*

Agniel, Bro. *10525* (3h); *10621* (1).
Aguilar, M. *87* (3f).
Alexander, R. C. — (3f).
Alfaro, A. *32378* (3h).
Allart, A. *76* (3c).
Allen, P. H. *52* (3c); *91, 1045, 1176, 1364* (3f); *1906* (3h).
André, E. K. *K862* (3e).
Antonio, Bro. *16E* (3f).
Arbelaez, E. P. & J. Cuatrecasas. *2456* (3h); *6565* (3).
Aristé-Joseph, Bro. *A975, 1060* (3); — (3f).
Arsène, Bro. G. *34* (3); *128, 389, 1957* (3f); *2729* (3, 3f); *5494* (3); *10058* (3h).

Artemio, Bro. *72* (3).

Baker, C. F. *7* (3); *163, 618* (3f); *824* (3).
—— & H. A. Van Hermann. *4253* (3b).
Bangham, C. M. *341* (3h).
Barber, H. S. *23* (3c).
Barnes, C. R., C. J. Chamberlain & W. J. G. Land. *34* (3i).
—— & W. J. G. Land. *203* (3).
Bartlett, H. H. *11069* (3c).
Berg, N. K. — (3c).
Berlandier, J. L. *566* (3f).
Biltmore Herb. *11079, a, b, c, d, & e* (3c).
Biolley, P. *43, 7403* (3h); *8977* (3).
Bodin, J. E. *129* (3c).
Bogusch, E. R. *115* (3c).
Botanic Station. *508* (3).
Bourgeau, E. *1512, 1669* (3i).
Brace, L. J. K. *1527, 3541* (3b).
Brandegee, T. S. — (3f).
Brenes, A. M. *5954, 13418, 15630* (3g); *16967* (3); *16998* (3h); *17050, 19308, 21480, 21917* (3); *21969, 21982, 22623* (3g).
Britton, N. L. *999, 2917, 3995* (3f).
—— & J. F. Cowell. *9902* (3b).
—— & A. Hollick. *2093* (3f).
—— & C. F. Millspaugh. *2442* (3b); *6145* (3f).
& P. Wilson. *511* (3); *4536* (3f); *14032* (3b).
——, —— & A. D. Selby. *14498* (3b).
Broadway, W. E. *7324, 7690* (3f).
Brown, S. *78* (3f).
Buckley, S. B. — (3c).
Bush, B. F. *312, 1211* (3c).

Calderon, S. *121* (3).
Cardenas, R. *375* (3d).
Carleton, M. A. *81* (3h).
Chapman, A. W. — (3c).
Chase, V. H. *7073* (3); *7481* (3f).
Chaves, D. *75* (3).
Clark, O. M. *3977* (3c).
Clemens, J. *609, 610* (3c).
Conzatti, C. *1683, 1981* (3h); *3948, 4430* (3f).
—— & Camino. *2447* (3).
—— & V. Gonzalez. *27* (3).
Cook, O. F. & R. D. Martin. *63, 197* (3).
Cooper, G. P. *54* (3); *103* (3h).
—— & G. M. Slater. *26* (3h).
Cooper, J. J. *5719, 10367* (3f).
Cuatrecasas, J. *1850* (3f); *9153* (3h).
Curtiss, A. H. *726* (3); — (3c).

Davidson, M. E. *68* (3h).
Deam, C. C. *161* (3f).
Delgado, E. *271* (3e).
Dewey, L. F. — (3b).
Dixon, R. A. *441* (3b).
Dodge, C. W. & V. F. Goerger. *9582* (3h).
—— & W. S. Thomas. *4784* (3h); *6324* (3f).
Drushel, J. A. *2844* (3c).
Dugand, A. *887* (3e).
—— & Barriga. *2476* (3f).
Duges, A. *173* (3); *281* (1).
Dunlap, V. C. *101, 349, 440* (3h).

Edwards, M. T. *482* (3f); *818* (3).
Eggert, H. — (3c).
Ekman, E. L. *2976* (3f); *10069* (3).
Elias, Bro. *428* (3e); *655* (3f).
Emrick, C. M. *167* (3f).
Englesing, F. C. *75, 94* (3f).

Fawcett, W. *8022* (3f).
Fendler, A. *101* (3e).
Ferris, R. S. *5436, 6078, 6231* (3f).
—— & C. D. Duncan. *3150* (3c).
Fisher, G. L. *125* (3c); *152* (3i); *191* (3c); *35506*, — (3).
Fredholm, A. *6413* (3c).

Gale. — (3c).
Garnier, Bro. A. *291* (3).
Gaumer, G. F. *580, 1858*, — (3f).
—— & sons. *23361, 23523* (3f); *23686* (3, 3f).
Gehriger, W. *565* (3).
Gentle, P. H. *208* (3f); *870, 2373* (3a).
Gentry, H. S. *5258* (3).
Ghiesbreght, A. *642* (3).
Goldman, E. A. *22* (3f); *461* (3); *578* (3f); *864, 904, 940, 983* (3).
Gomez, R. *822* (3).
Grant. *7298* (3h).
Greenman, J. M. *49* (3f); *191* (3i); *443, 5433* (3f); *5665, 5712* (3).
Gregg, J. *1110* (3).
Groth, H. A. *209* (3c).

Hagen, C. & W. von. *1104* (3f).
Hall, E. *53* (3c).

Popenoe, W. *690* (3).
Pringle, C. G. *1959* (3c); *4132* (1); *4923* (3f); *5447* (4); *5609* (3); *5914* (3i); *5973* (3); *7833, 8202* (3i); *8232, 8498, 9275, 9455* (3); *9662* (3f); *9688* (3).
Purpus, C. A. *7430, 10729* (3i).

Record, S. J. — (3a).
Rehder, A. — (3f).
Reko, B. P. *3348* (3h).
Renson, C. *8* (3).
Reverchon, J. *1195, 1197, 3827,* — (3c).
Roig, J. T. *3160* (3b).
Rojas, T. *67* (3f).
—— & A. Tonduz. *56* (3f).
Rose, J. N. *2670* (1); *4027* (3h).
—— & R. Hay. *5302* (3); *6184* (3i); *6354* (1).
& W. Hough. *4237* (3); *4245* (3i); *4351* (3h); *4363* (3); *4587* (3f); *4883* (3c).
——, A. Pachano & C. Rose. *23478* (3h).
—— & J. H. Painter. *7541* (3).
——, —— & G. Rose. *8497* (3); *10220* (3f).
—— & G. Rose. *22595* (3).
—— & P. G. Russell. *24292* (3f).
——, P. C. Standley & P. G. Russell. *13939, 14096, 14210* (3).
Rothrock, J. T. *180, 237* (3b).
Ruano, M. *405* (3f).
Runyon, R. — (3c).
Rusby, H. H. & F. W. Pennell. *143, 170* (3).

Saer, J. *65* (3e).
Sargent, C. S. — (3c).
Schery, R. W. *188* (3h); *204, 206* (3).
Schipp, W. A. *708* (3a).
Schott, A. *3* (3i); *177, 271* (3f); *643* (3); — (3f).
Schunke, C. *21, A116* (3); *293* (3j); *1492* (3).
Seaton, H. E. *300* (3i).
Seibert, R. J. *263* (3h).
Seler, G. & E. *2681* (3); *4913* (3f).
Shannon, W. C. *307, 384* (3f); *419* (3).
Skutch, A. F. *541* (3); *878* (3h); *1021* (3); *2368* (3h); *3266* (3g).
Smith, A. *H20, A316, H1670* (3g); *4215* (3h).
Smith, C. L. *118* (3); *296, 638, 1023 & 1030, 1030* (3f).
Smith, H. H. *492, 734, 735, 2727, 2816* (3h).
Smith, J. D. *1658A* (3h); *1991* (3f); *6450* (3h); *7393* (3g).
Solis, F. *266* (3).
Standley, P. C. *19339, 19718a, 19855, 20809* (3f); *21021, 21402* (3); *21837, 22300,* (3f); *22690, 22975* (3); *23520, 23857* (3f); *24587* (3h); *27924, 32230* (3f); *33209* (3g); *33368* (3); *34685* (3g); *35756* (3h); *36585* (3g); *36987* (3h); *39640, 39837* (3g); *40163, 41854* (3h); *42268, 52756* (3); *53743, 53926, 54021* (3h); *54127* (3); *54786, 54987, 55493* (3h); *55780, 58277, 59465, 60179, 60322* (3f); *61127, 61483* (3); *62039, 62048* (3h); *62146* (3f); *63263* (3); *63420, 63919, 64000* (3f); *65416* (3h); *66536,* (3f); *66190* (3); *66539, 66702, 66719, 66775, 67894* (3f); *68102, 68112, 68236* (3h); *69853, 72026* (3f); *72311* (3h); *74212* (3); *75248* (3); *77752, 78616, 78644, 79019, 79410* (3f); *79935, 81929* (3); *88014, 88119, 88240, 89189, 89488, 89571, 90542* (3f).
—— & R. Torres. *47926* (3g).
—— & J. Valerio. *43278* (3h); *44605, 46238* (3g); *49600* (3h).
Steere, W. C. *1127, 1618, 1642* (3f); *1924, 2020* (3).
Stevens, F. L. *301* (3g).
Steyermark, J. A. *29878* (3f); *30360, 30505, 30615* (3); *31634, 31635, 31790* (3f); *31959, 32851* (3); *33386* (3h); *33581* (3f); *34516* (3h); *34989, 36553* (3); *38665, 37878* (3f).
Stork, H. E. *101* (3h); *333* (3f); *1828, 2834, 2975* (3h).

Tamayo, F. *385* (3e).
Terry, R. A. *1386* (3f).
Tharp, B. C. — (3c).
Thieme, C. *5153* (3h); *5168* (3).
Thurrow, W. F. — (3c).
Tomas, Bro. *622* (3f).
Tonduz, A. *814, 1092* (3f); *2218* (3h); *2884* (3f); *6973* (3h); *6982* (3f); *7260* (3h); *7291* (3f); *7393, 8089* (3g); *8036* (3h); *8946* (3f); *11631, 11693* (3); *12485* (3g); *13149* (3h); *13485* (3f); *17554* (3).
Townsend, C. H. T. *49* (3c).
Tracy, S. M. *7476* (3c).

Trelease, W. — (3c).
Triana, J. J. *388, 3132* (3).
Tuerckheim, H. von. *II607, 882* (3f); *II1721* (3h); *II2312* (3f); *8185* (3h).

Ule, E. *9591* (3e).
University of Lima. *13, 75* (3).

Valerio, J. *66* (3g); *67* (3).
Valerio, M. *220* (3).
Van Herman, H. A. *253* (3f).
Vogl, Fr. C. *76* (3e).

Ward, L. F. — (3c).
Warner, S. R. — (3c).
West, J. *3552* (3).
White, P. & G. *70* (3f).
Wight, A. E. *22* (3f).
Wilkinson, E. H. *47, 102,* — (3c).
Williams, G. B. *70* (3c).
Williams, L. *506, 2675, 8068* (3e); *8336* (3f); *8977* (3); *9189, 9219* (3f).
Wilson, P. *42* (3h).
—— & Bro. Leon. *11297* (3f).
Woodson, R. E. & R. W. Schery. *188* (3h); *276, 302, 531* (3f); *550* (3h); *932* (3f).
Wooton, E. O. — (3).
Worthen, G. C. — (3).
Wright, C. *2064, 2065, 2068* (3c).
Wright, W. G. *1348* (3f).

Yuncker, T. G., R. F. Dawson & H. R. Youse. *5680* (3f); *5879, 5880, 6239* (3).
Yuncker, T. G., J. M. Koepper & K. A. Wagner. *8523* (3h).

Index to Specific and Varietal Names

New names, varieties and combinations are printed in **bold-face** type, synonyms in *italics*, and valid names in Roman type.

EXPLANATION OF PLATE

PLATE 14

Cutting from a plant of *Malvaviscus arboreus* var. *penduliflorus*, showing unusual morphology in the first formed leaves.

SCHERY—MONOGRAPH OF MALVAVISCUS

Explanation of Plate

Plate 15

Figs. 1–6. Six different specimens of *M. arboreus* vars. *mexicanus* and *penduliflorus* collected in the same locality in Chiriquí, Panama. Note the variation in leaf and petal shape, number and form of calyx and involucral lobes, differences in leaf margin, etc. The specimen of fig. 3 would be classified as var. *penduliflorus* on the basis of flower size, while the other specimens would fall into the var. *mexicanus* group. The specimens of figs. 1 and 2 would be almost on the border-line between these two varieties. × ½.

SCHERY—MONOGRAPH OF MALVAVISCUS

EXPLANATION OF PLATE

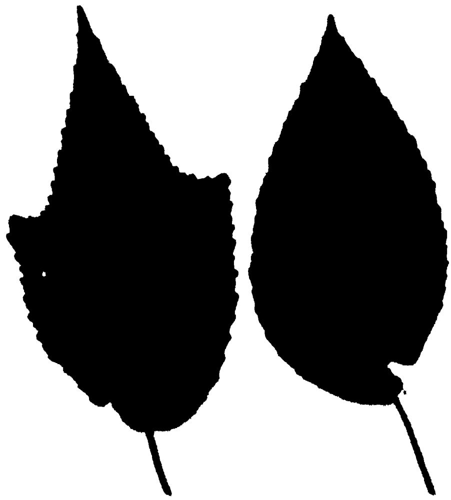
PLATE 16

Fig. 1. Two leaves from the same plant of *M. arboreus* var. *penduliflorus* growing in the Missouri Botanical Garden greenhouse. × ⅔.

Fig. 2. Dense velvety pubescence of lower surface of a leaf of *M. arboreus*. × 10.

Fig. 3. Stellate pubescence on upper surface of a leaf of *M. arboreus* var. *brihondus*. Note occasional larger hairs. × 10.

Fig. 4. Glabrous upper surface of a leaf of *M. arboreus* var. *mexicanus*. Note the longitudinal ridge of hairs on the upper side of the petiole in this specimen. × 10.



1

2

3

4

SCHERY—MONOGRAPH OF MALVAVISCUS

Explanation of Plate

PLATE 17

Fig. 1. Calyx of *M. arboreus* var. *mexicanus* with other floral organs removed: left—external view; right—calyx split open to show inner surfaces. × 4.

Fig. 2. Single petal of *M. arboreus* var. *mexicanus*. × 2.5.

Fig. 3. Upper portion of staminal column in three specimens of *M. arboreus* var. *mexicanus*. Note the erect position of the style branches and the five-toothed tip of the staminal column in the younger (upper) specimen. × 4.

Fig. 4. Involucre of *M. arboreus* var. *mexicanus* with all other floral organs removed: upper—involucre split open with inner surfaces exposed; lower—external view. × 4.

Fig. 5. Upper row, from left to right: empty opened carpel, seed, seed in position in opened carpel, single unopened carpel, and mature fruit of *M. arboreus* var. *mexicanus*. Lower row: same for *M. candidus* except mature fruit is omitted. × 2.

SCHERY—MONOGRAPH OF MALVAVISCUS

Annals
of the
Missouri Botanical Garden

Vol. 29 NOVEMBER, 1942 No. 4

CONTRIBUTIONS TO OUR KNOWLEDGE OF AMERICAN CARBONIFEROUS FLORAS[1]

IV. A New Species of Lepidodendron

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Previous investigations have established *Lepidodendron* as one of the most abundant and widely distributed genera during the Carboniferous period, and the results of the present study indicate that it was the dominant element of the southern Illinois flora in middle Pennsylvanian times.

Lycopod remains are present in almost every specimen of the hundreds of coal-balls collected during the past two years from the Pyramid mine of the Binkley Coal Company in Perry County, Illinois.[2] Over 100 stems referable to *Lepidodendron* have been found thus far. This study is based chiefly on a selection of about 25 of the best-preserved specimens exhibiting a representative picture of the structural variations found in the various orders of branching. Associated with the stems are leaves, roots, and reproductive organs. Some of these have already been described (Andrews and Pannell, '42) while others will be considered here and in later studies.

Lepidodendron scleroticum sp. nov.

The designation of a new species of this supposedly well-known genus probably needs a few words of explanation. Since Sternberg's

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[1] A study aided by a grant from the Penrose Fund of the American Philosophical Society.

[2] A detailed description of the occurrence of coal-balls at this locality has been given in the first of this series of contributions (Ann. Mo. Bot. Gard. 29: 1–18. 1942).

Issued December 18, 1942.

account of the type species in 1823, more than 100 others have been described from compression material and over 20 from petrified specimens. There is little doubt that a considerable amount of synonymy exists in this long list of names. It is equally obvious to any investigator who has studied the Carboniferous Lycopods at all carefully that we are only beginning to understand the morphological boundaries of the group. Very notable contributions relative to their reproductive organs have been made during the past few years (Arnold, '40; Hoskins and Cross, '41; Schopf, '38; Andrews and Pannell, '42). It is hoped that future studies will shed more light on the relationships between the cones and isolated vegetative remains.

Lepidodendron stems constitute the dominant element of our Pyramid Mine collections, and the genus is abundantly represented in the roof shales of certain southern Illinois mines. The large number of specimens at hand makes possible a much more complete description of the stem structure of the plant as a whole than do most of the previously described species, many of which are based on a single specimen. It will also be shown that *L. scleroticum* presents highly distinctive cortical characters which in themselves adequately justify the new specific name.

The stems range from 3 mm. to 9 cm. in diameter, while larger stelar fragments or portions of bark were found indicating stems as large as 30 cm. in diameter. Two specimens with abundant secondary growth have been selected to show the typical organization of the tissues and the distinctive features of the species (pl. 18, figs. 1 and 2). They are numbers WCB55 and WCB56 respectively, in the Washington University fossil plant collection. A description of these specimens is followed by a shorter consideration of certain others in order to present a composite picture of the shoot system as a whole.

The pith, which is present in all of the larger stems, is surrounded by the xylem cylinder of primary and secondary origin, which is in turn surrounded by the phloem. The cortex may be divided into three zones, although these are not always distinct. The inner cortex immediately exterior to the phloem is composed of delicate parenchymatous and small sclerotic cells. The parenchyma cells are often poorly preserved and the sclerotic cells crushed. The highly distinctive middle cortex consists of sclereids grouped into nests and surrounded by parenchyma. The outer cortex presents a dicty-

oxylon arrangement of slightly elongate thickened cells and parenchyma.

The periderm forms a large portion of the stem. It is composed of compactly arranged cells that were intimately connected with the mechanical support of the tree. The cork cambium is well preserved in some of the smaller stems.

Development of the Primary Xylem.—

In *Lepidodendron scleroticum* there is a marked relationship between stem size and primary xylem development. In small twigs from 3 to 10 mm. in over-all diameter, the xylem cylinder is typically protostelic, measuring from .26 to .78 mm. (pl. 19, fig. 6). The protoxylem is exarch and unevenly distributed around the periphery. Branches with steles as small as this never exhibit any secondary xylem. Stems from 10 to 22 mm. show a mixed protostele varying from 1.04 to 1.56 mm. in diameter (pl. 19, fig. 3). When the cylinder of the primary xylem attains a diameter of 1.5–2 mm. secondary wood begins to form. In older stems from 3 to 5 cm. in diameter the

TABLE I

SHOWING THE RELATIONSHIPS BETWEEN DIMENSIONS OF PITH AND PRIMARY AND SECONDARY XYLEM IN THE VARIOUS BRANCH ORDERS

Stem No.	Total diameter of stele	Radius of the primary body	Radius of the primary xylem (X_1)	Radius of the secondary xylem (X_2)
	mm.	mm.	mm.	mm.
WCB16 (2)	.26	.13	.13	None
WCB55A (2)	.39	.18	.18	None
WCB54 (2)	.45	.23	.20	None
WCB265 (2)	.52	.26	.24	None
WCB16B (3)	.52	.26	.24	None
WCB54 (3)	1.04	.53	.31	None
WCB55A (2)	1.10	.55	.45	None
WCB124A (1)	1.30	.65	.55	None
WCB54C (7)	1.56	.78	.52	None
WCB16B (3)	1.69	.64	.58	None
WCB54A (8)	1.69	.84	.71	X_2 beginning
WCB58A (2)	1.88	.94	.78	X_2 beginning
WCB106A (1)	2.08	1.04	.80	None
WCB124A (1)	2.08	.84	.62	.19
WCB19C (1)	4.81	1.23	.65	1.17
WCB135A (2)	5.20	1.69	.91	1.04
WCB180A (2)	5.72	1.30	.84	1.56
WCB57A (2)	5.98	1.69	.91	1.43
WCB56B (7)	6.24	1.82	.97	1.30
WCB148A (2)	6.76	1.82	1.04	1.52
WCB55A (10)	6.86	1.56	1.04	1.82
WCB61B (1)	7.80	1.82	1.77	2.08
WCB18A (2)	7.87	1.95	1.77	2.21
WCB20X (5)	8.12	2.04	1.04	2.20

xylem cylinder averages 6.7 mm., of which 3.1 is primary and 3.6 is secondary. The pith is now well developed, forming about one-half the total diameter of the primary body. Figure 6 is a photograph of the largest stele found, the secondary xylem measuring 22 mm. in radius and the primary xylem 6–7 mm. Table 1 presents a more detailed compliation of the dimensions of 24 well-preserved stems.

The sequence of development shown in the table is uniform, and since only stems with well-preserved cortical tissues were used there is no reason to believe that they are not all referable to *L. scleroticum*.

A study of this series not only clearly illustrates the intra-stelar origin of the pith, but it presents evidence that the whole primary body increases in size even after the initiation of secondary wood. The evidence is based on the three following points: (1) no secondary wood around a protostele or a small primary cylinder was observed; (2) all the larger stems showed a siphonostele which probably developed from the smaller mixed protostele during the formation of the first few mm. of secondary growth; (3) wedge-shaped gaps exist between the secondary tracheids along the contact zone between the primary and secondary xylem (fig. 8) which are constant in all stems of any appreciable secondary growth. The gaps may be due either to pressure exerted by the increased circumference of the primary cylinder or to the decay of parenchymatous tissue laid down during the early stages of cambial activity. The rather fine preservation of the immediately adjoining parenchyma cells in both primary and secondary wood leaves little doubt that the first explanation is the correct one. The increase in size of the metaxylem was probably accomplished both by the maturation of the individual tracheids (cf. figs. 3, 6) as well as by the division of parenchyma cells associated with the tracheids.

Bower ('30) has been the most active investigator of the development of the primary body of vascular cryptogams. His research attempted to determine the physiological relationships between tracheids and living parenchyma cells which seemingly govern the ontogeny of the primary stelar body. He dealt largely with the different types of steles exhibited in the various species of Lycopods and concluded that the primitive xylic column in the fossil forms may undergo one or more of four types of progressive changes in order to maintain a more or less constant tracheid-parenchyma relationship. These may be briefly summarized as:

1. A "fluting" of the periphery of the primary body is noted in certain species (*L. Harcourtii* Witham, and *L. selaginoides* Binney). This fluting resulted in a series of concave crenulations which increased the surface area.
2. Medullation occurs in most Lepidodendrons, but some are reported as protostelic while others develop a mixed protostele or siphonostele. Bower described branches of *Lepidophloios Wunschianus* Carruthers which show a general relationship of stem size to pith development, but he made no observations on the beginning of secondary growth in the various twigs.
3. In species which developed secondary xylem the wood rays apparently served to retain a more or less constant tracheid-parenchyma relationship. Secondary wood may occur in both protostelic and medullated species although in some it is reported as absent.
4. Segregation of the primary xylem into separate strands occurs in certain *Lepidostrobus* cones (*L. Brownii*).

These four tendencies apparently helped maintain a nearly constant ratio of living to dead cells in the progressive evolution of the vascular tissue in the fossil Lycopods.

The Secondary Xylem.—

The fossil Lycopods produced little secondary wood in comparison with the size of the trunk. In most of the *Lepidodendron scleroticum* stems studied, which were about 4 cm. in diameter, the ring of secondary xylem measured from 1 to 2 mm. in width. Isolated fragments in which the secondary wood reached a radial dimension of 5 cm. were found, but it cannot be said definitely that they belong to *L. scleroticum,* since the outer parts of the stem were not preserved. However, the specimen previously discussed (pl. 19, fig. 4), which developed secondary wood 3 cm. in thickness, possessed enough fragments of the characteristic cortical sclerotic nests to be assigned to this species.

At first, secondary growth is slight and develops frequently only on one side, with gaps between the active cambial cells. In such specimens the cambial development is closely comparable to that found in *Lepidodendron fuliginosum* Williamson, *L. intermedium* Williamson, and *L. obovatum* Sternberg. This peculiar type of cambial activity is described by Scott ('20, p. 137), for the above three species as follows:

"The cambium was an anomalous one, arising in various parts of the phloem zone and pericycle. It produced a good deal of the secondary parenchyma, among which there are usually scattered groups of wood; the secondary tracheids have a very sinuous and irregular course. We may regard these species as exhibiting either a primitive and rudimentary or reduced form of secondary wood."

Lepidodendron scleroticum shows this supposed primitive character only at the beginning of the growth of secondary wood, for after 10 to 20 xylem cells have been formed in an irregular manner the tracheids around the entire primary stele develop actively. There is frequently unequal growth of secondary wood on one side of the cylinder, probably due to some environmental condition.

The first few secondary tracheids formed average 52 μ in width; but after 10 to 20 cells have developed, the tracheids range from 88 to 104 μ. None of the secondary tracheids reached the robust size of the primary ones which average 130 μ, some even 195 μ. Although the length of the tracheids is difficult to follow, due to their frequent distortion by rays and traces, approximately 30 cells were followed in their entirety. These were found to average 12 mm., some reaching 15 mm. Near the ends, the tracheids gradually tapered to a point.

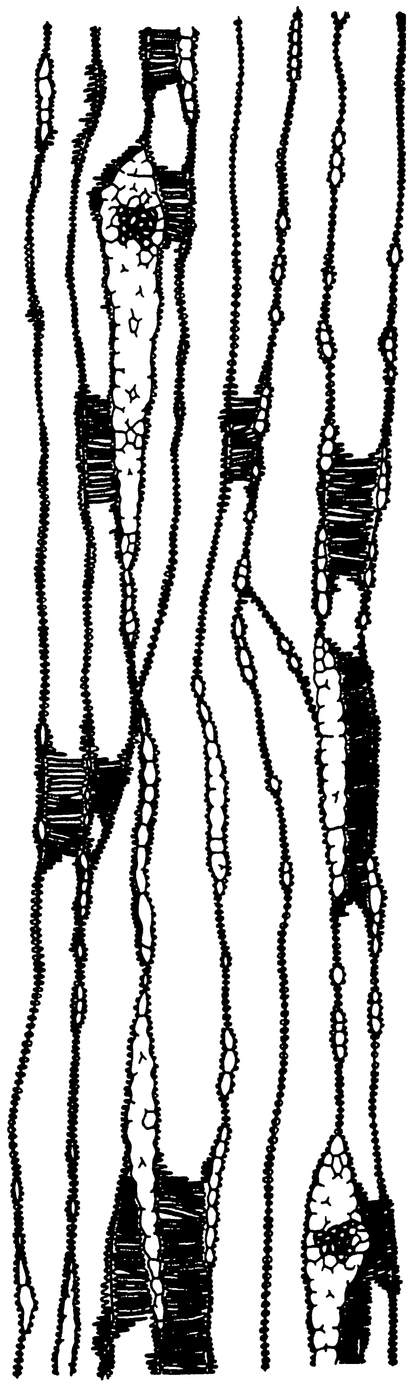
Using the maceration technique, the pronounced scalariform sculpturing of the secondary walls of the primary and secondary tracheids was studied in detail (fig. 5). The transverse bars are about 5.3 μ in width and are spaced at a slightly greater distance. They extend completely across the wall face and at the corners merge into a continuous layer. The bars frequently dichotomize but with no regularity. Extending across the openings between the bars is a series of numerous fine threads which have been described in several other species of *Lepidodendron* as well as in *Lepidostrobus Bertrandi* Zalesky, *Sigillaria Boblayi* Brongn. and *Stigmaria ficoides* Brongn. Three interpretations of their morphology have been recorded:

1. Seward and Hill ('00) describe them as post-mortem changes in the primary wall which made the pit-closing membrane torn and fragmentary.

2. Calder ('32) considers them, in *Lepidodendron Brownii* Unger, as tertiary thickenings laid down in a thin layer around the bars of the scalariform thickenings, with the fine threads connecting the layers.

3. Arnold ('40), in his description of *Lepidodendron Johnsonii*, regards them as part of the secondary thickenings which lay against the primary wall and bridged the pit cavity on the inside.

1



2

Text-figs. 1–2.—*Lepidodendron scleroticum:* fig. 1, longitudinal section of scalariform thickenings, × 100; fig. 2, tangential section of wood, × 50.

A study of the macerated tracheids of *L. scleroticum* presents strong evidence supporting their secondary nature as described by Arnold. The threads show definite connection with the secondary thickenings (text-fig. 1). They are also too evenly spaced to be torn fragments of the primary thickenings as Seward and Hill regarded them. Their structure appears similar to the outgrowths of the secondary walls in the vestured pits of the Angiosperms described by Bailey ('33). The scalariform thickenings and the threads seem to be of the same material with no outer layer of the bars or tertiary thickenings as reported by Calder. The fine strands are, as far as it is possible to determine, secondary thickenings of the same material as the scalariform bands lying next to the primary wall connecting adjoining bars.

The wood rays vary from a single row of cells to many cells high and several cells wide (text-fig. 2). The cells range from 15 to 30 μ in diameter and are about three times as long (radially). The walls of all the ray cells are characterized by delicate scalariform thickenings although these never become as pronounced as in the tracheids or leaf trace elements. There is no reason to believe, however, that they were not living cells, and they present the only possibility of maintaining the ratio of living to dead cells in the secondary xylem.

On the basis of studies in other plant groups the rays of *L. scleroticum* are clearly of an exceedingly primitive nature. This is suggested both in the variability in size of the rays as a whole, as well as the wide range in individual cell size. A less specialized ray structure would be difficult to conceive.

The leaf trace originated from the protoxylem cells at the periphery of the primary xylem and followed a horizontal course through the entire extent of secondary wood in all the specimens studied. This feature is of considerable interest since the largest stems had certainly shed their leaves before any appreciable amount of secondary growth. Both the tangential sections of the leaf bases and the impressions of the *Lepidodendron* stems in the shale indicate that only small twigs actually bore leaves. This persistent growth of the leaf trace has been noted in certain species of *Araucaria,* living and fossil. The character is probably present in other species of *Lepidodendron,* but it has not been studied in detail.

Near the primary wood the trace is surrounded by only a few ray cells, but as it progressed through the secondary wood the surrounding ray tissue increased in height and breadth. Text-fig. 2

was drawn from a tangential peel taken about 3 mm. from the periphery of the primary wood. The amount of xylem cells remains relatively constant in all the traces, as well as within the same trace as it progresses through the secondary wood. The protoxylem, if such were differentiated, is not distinguishable.

The leaf trace follows an upward course through the cortex and then resumes a horizontal course through the extensive periderm tissue. This will be considered in more detail in the discussion of the extra-stelar tissues.

Branching.—

An excellent specimen showing monopodial branching is included in our collections (No. WCB254). The block was sectioned into nine parts and the stele studied at the various stages of development. The progressive origin and departure of the branch trace, with the closing of the gap, are illustrated in pl. 21, figs. 13–16. In fig. 13 the stele is seen before the departure of the branch, while fig. 14, which is 5 mm. above, represents the beginning of the trace. In fig. 15 the branch trace has progressed in its upward course 10 mm., and in fig. 16 about 20 mm., from the point of origin. The new stele is at first crescent-shaped, and as it departs, some secondary wood is carried with the primary tracheids (fig. 15). The branch gap is then bridged and the stele of the branch becomes circular, losing the secondary wood. Shortly above the last stage figured, the specimen becomes poorly preserved and the newly formed branch is completely lost.

In fig. 16 at *p* a band of tissue, secondary in origin and presumably periderm, may be noted. In all probability this represents the junction of the stem and branch cork but it was not possible to follow it up high enough to observe the actual separation of the branch.

Most of the stem compressions observed in the roof shales in southern Illinois mines indicate that dichotomy was of more frequent occurrence than monopodial branching, and only a few poorly preserved specimens branching dichotomously have been found in the coal-balls. Although a reconstruction of *L. scleroticum* probably compares closer to Hirmer's for *L. obovatum* (Hirmer, '27) than it does to Scott's for *L. elegans* (Scott, '20) the types of branching undoubtedly varied considerably in different species.

Cambium and Phloem.—

The delicate nature of the cambium and phloem prevents good preservation in fossil plants. In *L. scleroticum,* these tissues are

partially preserved only in the better specimens. The cambium appears to have been composed of several layers of cells, and the surrounding phloem area is very small when compared with the large amount of secondary wood. These cells are represented in fig. 11. There have been two interpretations of the structure of the phloem cells in *Lepidodendron*: one, supported by Weiss ('01), states that sieve cells are present; the other view, that of Seward ('02), holds that the phloem cells were not morphologically sieve cells but a type of secretory cell. It is only possible to say that the phloem in *L. scleroticum* probably consisted of very primitive undifferentiated parenchymatous cells not great in extent and little of secondary origin.

The Cortex.—

The cortical tissue is composed of three zones which are distinct even in young twigs. The inner cortex directly adjoining the phloem consists of delicate parenchymatous cells and small heavily thickened sclerotic cells. The parenchymatous cells are usually poorly preserved and the sclerotic cells crushed. The disorganized tissue forms a band next to the xylem in most of the stems (fig. 21).

The remaining cortical cells, separated from the inner cortex by a cavity caused by the decay of that tissue, are well preserved. The middle cortex is composed of heavily thickened sclerotic cells grouped into nests and surrounded by parenchymatous cells most abundantly associated with the leaf traces which follow a gradual upward course through the cortex. The position, arrangement, and size of these cells may be noted in figs. 17, 18, and 19.

The outer cortex consists of parenchymatous and sclerenchymatous cells which are less thickened and more elongated than the sclerotic ones of the middle cortex. At first there are only a few small elongate sclerenchymatous cells among the sclerotic nests, but in the outer portions of the cortical region a reticulate network is formed from the decayed parenchymatous cells surrounding the leaf trace and the fibrous sclerenchyma (fig. 20).

The composition and arrangement of the cortical tissue present the most distinctive characters of *Lepidodendron scleroticum.* The sclerotic nests, which have never been reported in a species of *Lepidodendron,* make possible specific recognition when only fragments of the stems are preserved. The reticulate network of the outer portions of the cortex has been described in *L. esnostense* and *L. rhodumnense* Renault ('79). These species differ from *L. sclerot-*

icum not only in cortical tissue, for they have no sclerotic nests, but they were protostelic with no secondary xylem.

The Periderm.—

The periderm of the fossil Lycopods is one of their most characteristic features, since it was not primarily a protective tissue, but served as the main support of the stem. The early English paleobotanists regarded it as vascular tissue or "pseudo-wood" (Binney, 1862, Witham, 1833). Williamson (1872) was the first investigator to dispel this erroneous concept. Since that date our knowledge of this tissue has rapidly increased, terminating in the thorough study by Kisch ('13).

In *Lepidodendron scleroticum,* the cork cambium arises early in the growth of the twig, often before the mixed stele has developed an active vascular cambium. The phellogen originates 5–10 cells within the epidermis and divides rapidly. As in other species of *Lepidodendron,* the division is the exact reverse of the phellogen activity in modern trees, for the cambium lays down the great bulk of the tissue centripetally with only a small portion of phellem. A young twig shows little cellular differentiation of the cork (fig. 23) until after 2 to 3 mm. of growth. Its cells near the leaf bases divide radially, which increases the circumference of the stem and keeps the leaf bases intact. Most of the periderm cells are 6–10 times longer than broad and are sharply pointed at the ends. They vary from thick and heavy to fragmentary and thin (fig. 22). The transition occurs in frequent succession and the partial decay of the thin-walled cells produces a series of holes. Such a periderm structure has been described in *Lepidodendron selaginoides* and *Lepidophloios Wunschianus,* but the degree of thickening of the preserved cell walls in those species is more constant. These gaps in the periderm have been described by Hovelacque ('92), in *Lepidodendron selaginoides,* as less-resistant layers formed at periods of sluggish growth, but recently they have been interpreted in another species as secretory strands (Arnold, '40). Although some of the cells surrounding the cavities show horizontal septa in tangential section, there are no other indications that the gaps were anything but decayed cells of less-resistant structure.

The leaf trace follows a horizontal course through the great mass of periderm. Small sclerotic cells of the cortex may follow the trace for a distance into the cork, but the parenchyma cells associated with the trace have greatly decreased in mass.

The Leaf Bases.—

The structurally preserved leaf bases of *L. scleroticum* were studied by peels made tangential to both young and old stems and were found to have the characteristic shape shown in fig. 26. The general appearance of the leaf cushions is a spiral arrangement of rhomboid structures separated by a narrow groove where the stem surface was exposed. A small ligule, sunken in a pit, appears near the apex of the cushion. Beneath the ligule is the vascular bundle surrounded by a cavity of decayed parenchyma and phloem. In most species, parichnos strands are present on either side of the vein. Young twigs of *L. scleroticum* show parichnos composed of 10–15 parenchyma cells, but in older cushions the parenchyma cells and phloem have decayed, leaving a cavity surrounding the lower parts of the xylem cells of the trace.

Several isolated fragments of leaf bases referable to *Lepidophloios* were also found in the Pyramid Mine coal-balls (fig. 24). Judging from the relatively few specimens found, however, this genus constituted but a minor element in the flora. A considerable number of well-preserved supposed *Lepidodendron* stems have been checked by means of sections taken through the leaf cushions to insure their correct identification. It is hoped that future collections may shed additional light on this *Lepidophloios* species.

An attempt has been made to correlate *Lepidodendron scleroticum* with certain of the large Lycopod trunk compressions occurring above the same coal seam in adjacent parts of Illinois. Approximately 25 specimens of stem compressions of various sizes were collected from the shale above coal #6 at the Old Ben Mine #11, Franklin County, Illinois. Exact specific determinations of impressions and compressions is difficult due to the varying degrees of preservation. It was possible, however, to separate the collection with reasonable accuracy into two species of *Lepidodendron* and one of *Lepidophloios*. The impressions of the leaf bases of *Lepidophloios laricinus* Sternberg closely resemble those of the petrified *Lepidophloios* figured. Of the two Lepidodendrons, *L. Volkmannianum* Sternberg ('25) compares more favorably with leaf bases of *L. scleroticum*. The other *Lepidodendron* impressions are probably *L. rimosum* Sternberg, for the leaf bases are slender. *Lepidodrendon Volkmannianum* (fig. 26) has been reported a number of times from the southern Illinois area, although it was described under different specific names (Lesquereux, '66, '70; Noé, '25).

The size of the impression specimens of *L. Volkmannianum* on the shale above the coal shaft makes a probable reconstruction possible. Figure 26 is one of the smaller stems, about 1½ inches in diameter. It was selected as an illustration because its size is comparable to the majority of the *Lepidodendron scleroticum* specimens, and although the trace and parichnos cannot be clearly observed the leaf scar is easily recognized. The stem branches dichotomously at the top, but the preservation of one branch is poor. Other specimens show leaf bases from ½ to ¾ inches wide. Judging from the size relationship of leaf bases and stem in the completely preserved impressions, these larger specimens would probably have measured 1–2 feet in diameter.

Economic Importance.—

In view of the fact that *Lepidodendron* stem remains are by far the most frequently encountered fossils in the Pyramid Mine coal-balls it is of interest, economically, to note that the coal itself is in all probability composed very largely of the stems and leaves of this plant. Since the periderm constitutes the greater part of the stems it is that tissue which is largely responsible for this rich deposit of coal.

Diagnosis: Primary body protostelic to siphonostelic depending on stem size; secondary xylem present, abundantly so only around fully developed siphonosteles; inner cortex characterized by prominent sclerotic nests, outer cortex a reticulate sclerotic net in tangential section; massive periderm irregularly zoned by decay of less-resistant cells; leaf cushions resembling closely those of *L. Volkmannianum.*

Locality and Horizon: Pyramid Mine of the Binkley Coal Company, Perry County, Illinois; coal #6, Carbondale formation, middle Pennsylvanian.

Type specimens: WCB55 and WCB56, Washington University (St. Louis).

Lycopod Organs Associated with L. scleroticum.—

Leaves: Many Lycopod leaves were found preserved near the petrified *Lepidodendron* stems. Although the evidence strongly suggests their affinity with *L. scleroticum,* no stems were found actually connected with the Lycopod leaves. The leaves vary from 1

to 5 mm. in width. Although their shape is frequently distorted, all their internal tissues show the same general arrangement. The length of the leaves is impossible to determine accurately since they were curved and broken before petrifaction. Several could be measured from 2 to 3 cm. in length without any appreciable change in thickness.

The xylem occurs in a single horizontally elongated strand composed of 40–50 tracheids, the amount of xylem varying with the leaf size. The protoxylem cells are difficult to distinguish, but they probably occur along the abaxial margin of the bundle. The metaxylem consists of scalariform tracheids. The phloem is concentrated on the abaxial side of the xylem and in some cases may enclose the entire xylem strand. A bundle sheath of thick-walled sclerenchyma cells surrounds the vein but is especially concentrated near the phloem. Around the bundle sheath, but more pronounced on the lower side, is an additional sheath of transfusion cells from 4 to 6 layers thick. Their diameter is equal to or greater than the xylem tracheids. Parenchymatous cells of about the same size but without the thickenings are mingled with the transfusion cells.

The hypodermal layers, from 4 to 6 cells in thickness, add another unique character to the leaf structure. The tissue is composed of elongate sclerenchyma with transverse end walls, and presents a uniform transition from small, heavily thickened cells immediately beneath the epidermal layer, to larger, less-thickened ones composing the last few rows.

The stomatal grooves appear on either side of the thickened portion of the blade surrounding the vein. The sub-stomatal area consists of modified hypodermal cells with air passages between the groups of small rectangular cells.

The mesophyll is poorly-preserved but, as far as can be determined, it consists of more or less isodiameteric cells closely packed together. There appear to be no air spaces between cells in the blade itself, but there are large ones in the stomatal chamber. No evidence of differentiation into palisade and spongy tissue exists. The mesophyll, which was probably the only chlorophyllous tissue, constitutes a relatively small portion of the leaf.

Lycopod leaves have been described in this country by Graham ('35) and Reed ('41) under the generic name *Lepidophyllum*. These leaves, associated with *Lepidodendron scleroticum*, compare closely with *Lepidophyllum Thomasi* Graham.

Associated Fructifications: Several Lycopod microsporangiate cones and many seeds, one containing a well-preserved gametophyte, were found in the coal-balls. A complete description of these fossils has been presented under the name *Lepidocarpon magnificum* (Andrews and Pannell, '42). Although the evidence is incomplete it seems likely, on the basis of association, that these fructifications belong to *Lepidodendron scleroticum.*

Discussion.—

An observer of the abundant Lycopod remains of the Carboniferous period cannot help postulating an explanation for the extinction of that great flora. The climatic conditions of that era have been considered as producing a swampy habitat similar to the present-day great Dismal Swamp in Virginia. This belief is substantiated by the associated fern and horsetail remains occurring with the Lycopod fossils. The great abundance of Lycopod organs and the excellent preservation of the external surface of the stems give considerable evidence for the "in situ" origin and fossilization of the material.

A study of the petrified Lepidodendrons presents a striking variation from the usual concept of hydrophytic characters. The evolutionary tendency in these Lycopods was towards extreme bulk of dead cortical tissue. This tendency expressed itself in the stem by the bulky periderm and the small xylem and phloem cylinder, and in the leaves the hypodermal layer decreased the photosynthetic area. The apparent xerophytic modification of the leaves may have come about to prevent evaporation, not because of the scarcity of water but *because the small stele was unable to conduct rapidly enough.* The tree would be efficient under moist conditions as the seeds were probably quick to germinate and growth was apparently regular and rapid. But with the increasing dryness of the Permian period, the tree with its excessive modification in bulk and poor conducting and photosynthetic abilities rapidly became extinct.

Acknowledgement.—

The writer wishes to express her appreciation of the many services rendered by the staff of the Missouri Botanical Garden during the course of this work and is especially grateful to Dr. Henry N. Andrews for his patient guidance and constructive criticism. Thanks are also due the Binkley Coal Company for their continued good will and cooperation in allowing coal-ball collecting in the Pyramid Mine.

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EXPLANATION OF PLATE

PLATE 18

Lepidodendron sclerotioum

Fig. 1. Transverse section of stem: oc, outer cortex; mc, middle cortex; Lt, leaf trace. WCB55A.7, × 3.

Fig. 2. Longitudinal section of stem. WCB56I.20, × 3.

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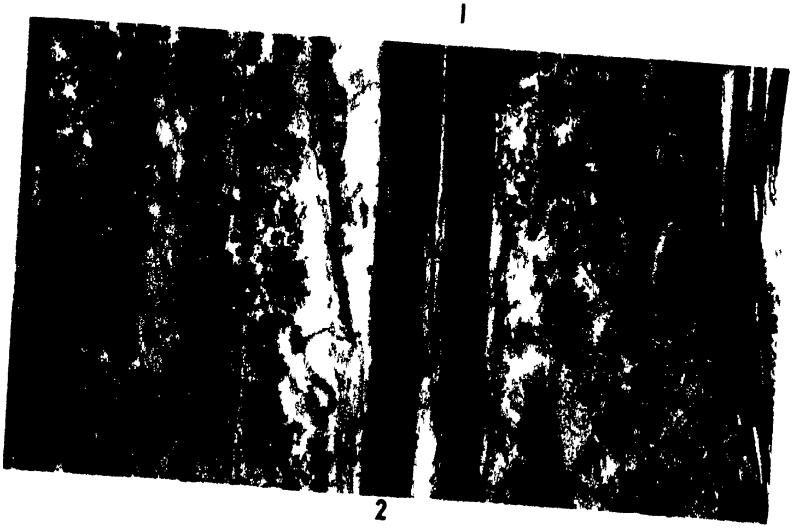

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PANNELL—AMERICAN CARBONIFEROUS FLORAS. IV

Explanation of Plate

PLATE 19

Lepidodendron scleroticum

Fig. 3. Transverse section of mixed protostele. MCB54.3, × 57.

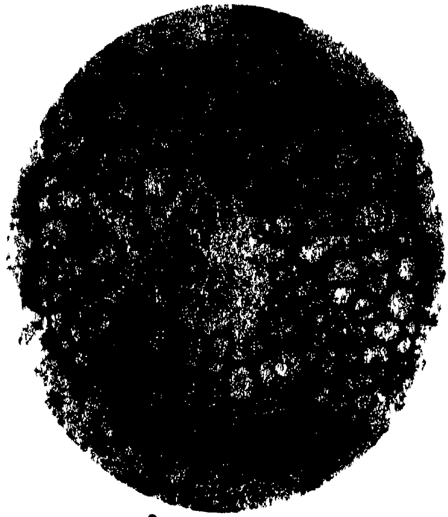
Fig. 4. Transverse section through a portion of a large stele. WCB42.2, × 3.6.

Fig. 5. Macerated tracheids showing "vestured pits." Slide 1213, × 290.

Fig. 6. Transverse section of protostele. WCB54.3, × 57.

Fig. 7. Transverse section of siphonostele. WCB253E.B1, × 14.

Fig. 8. Transverse section through contact zone of primary and secondary xylem. WCB56B.7, × 57.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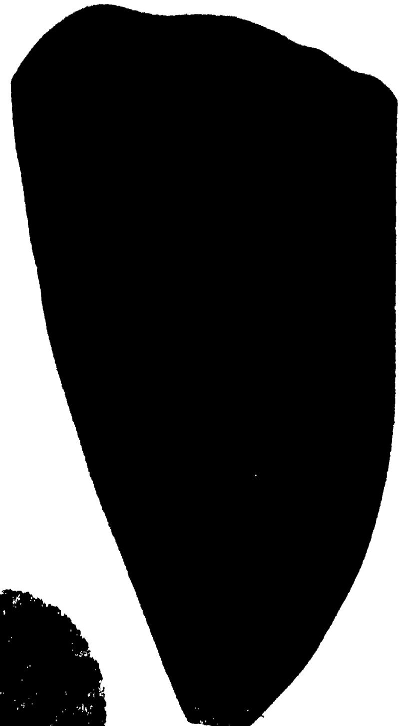
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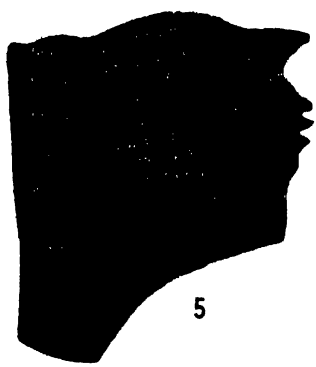
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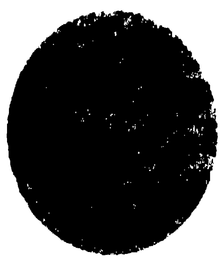
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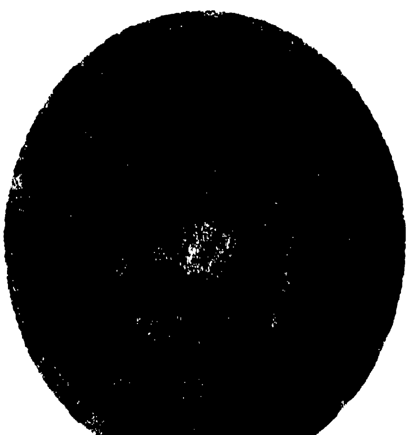
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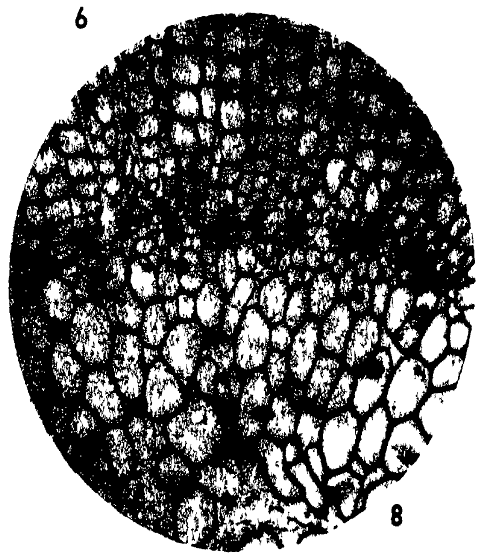
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PANNELL—AMERICAN CARBONIFEROUS FLORAS. IV

Explanation of Plate

PLATE 20

Lepidodendron scleroticum

Fig. 9. Leaf trace passing through secondary xylem, in radial section. WCB82B.S3, × 100.

Fig. 10. Wood-ray cells in radial section. WCB90B.1, × 200.

Fig. 11. Transverse section through outer part of secondary xylem and phloem. WCB55A.10, × 75.

Fig. 12. Showing course of leaf trace from primary into secondary xylem. WCB56I.2, × 80.

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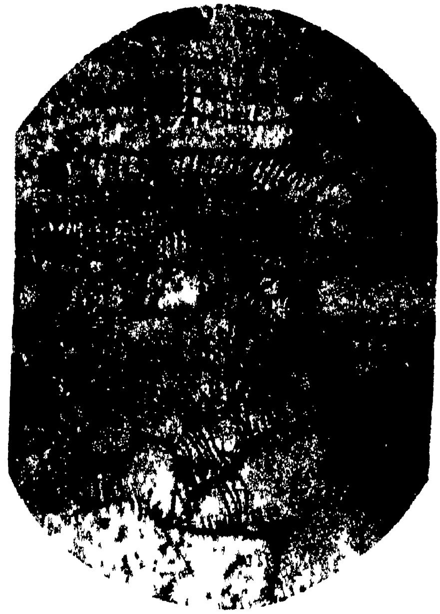

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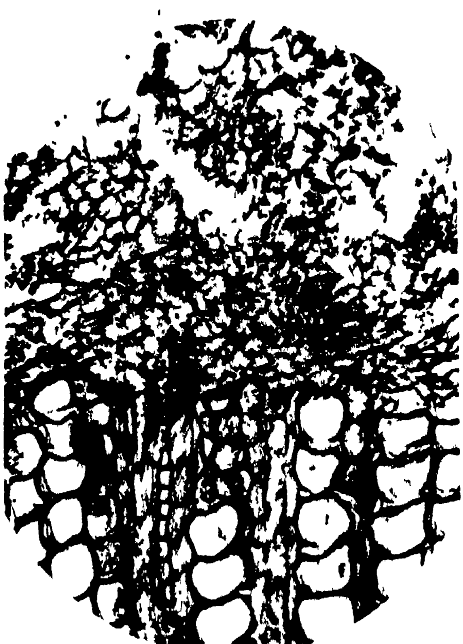

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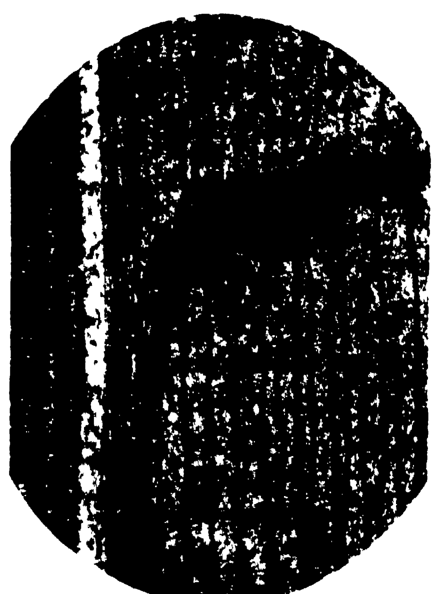

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PANNELL—AMERICAN CARBONIFEROUS FLORAS. IV

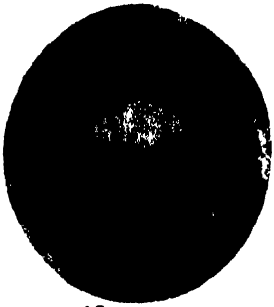
Explanation of Plate

PLATE 21

Lepidodendron sclerotioum

Figs. 13–16. Part of a series of peels tracing the origin and departure of a branch stele: p, periderm. All figures × 8.

Fig. 13. WCB253A.1.
Fig. 14. WCB253C.T2.
Fig. 15. WCB253D.T1.
Fig. 16. WCB253F.T2.



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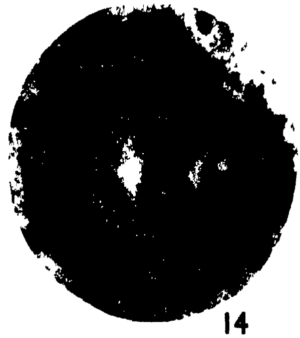

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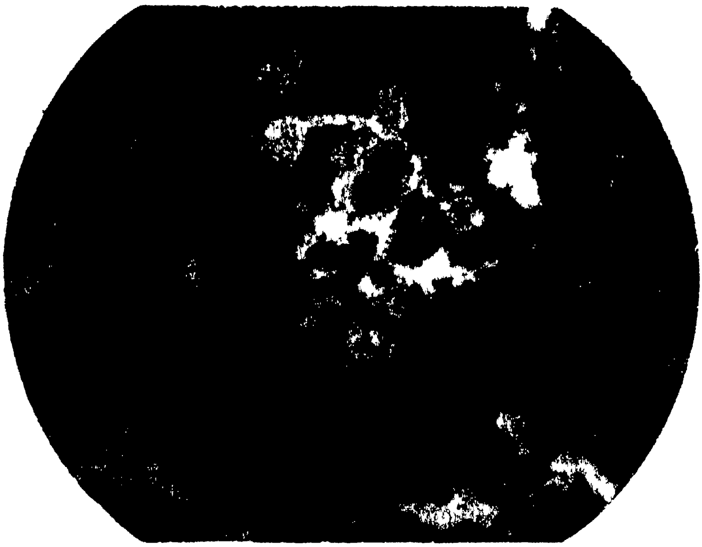

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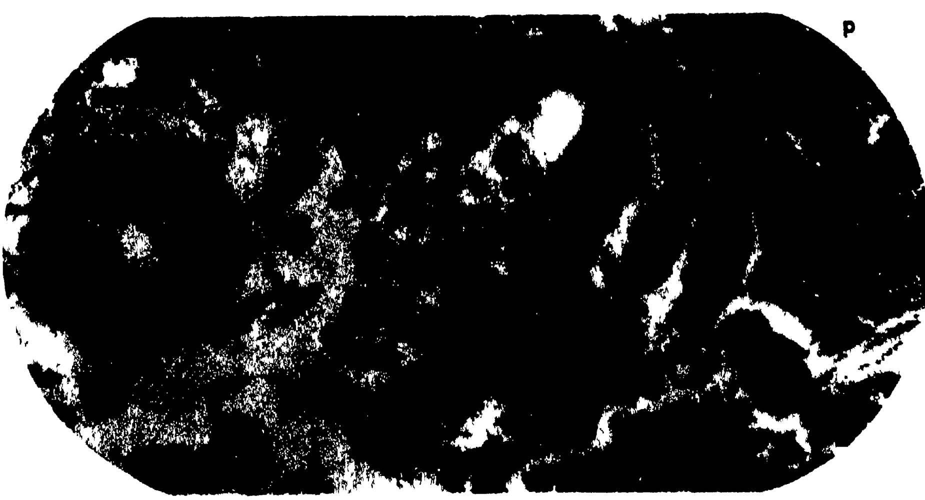

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PANNELL—AMERICAN CARBONIFEROUS FLORAS. IV

EXPLANATION OF PLATE

PLATE 22

Lepidodendron scleroticum

Fig. 17. Transverse section of cortex. WCB55A.7, × 8.
Fig. 18. Radial section of cortex. WCB56I.20, × 8.
Fig. 19. Tangential section through central region of cortex. WCB55III.515, × 7.
Fig. 20. Tangential section through outer region of cortex. WCB56I.B2, × 5. See text for detailed explanation.


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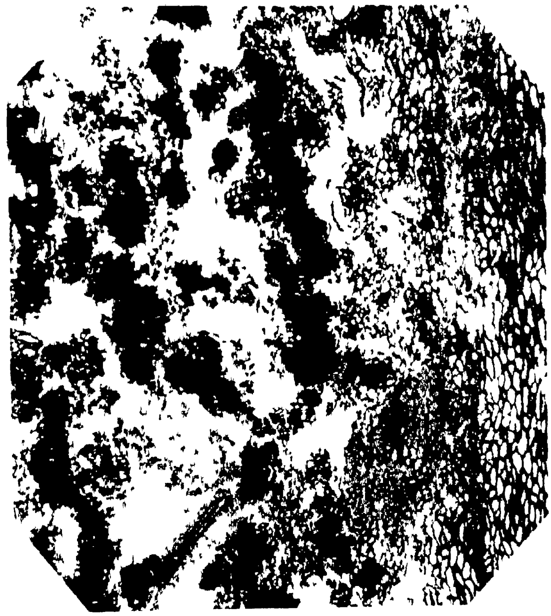
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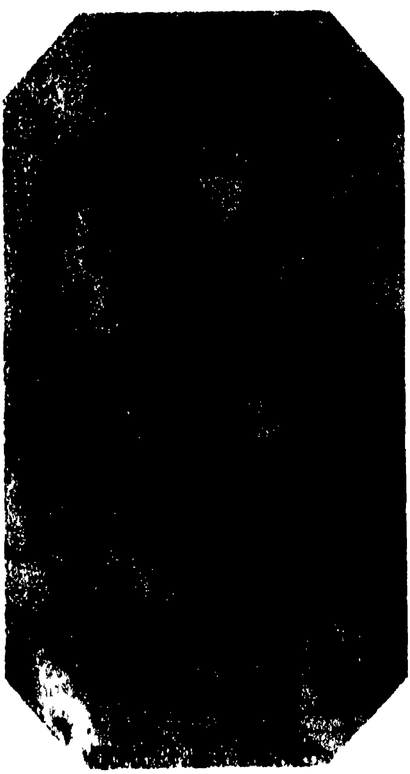
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PANNELL—AMERICAN CARBONIFEROUS FLORAS. IV

EXPLANATION OF PLATE

PLATE 23

Lepidodendron scleroticum

Fig. 21. Transverse section through young stem. WCB16C, × 10.

Fig. 22. Transverse section through periderm and leaf bases of a comparatively old stem. WCB55A.7, × 10.

Fig. 23. Transverse section through periderm and leaf bases of a young twig. WCB54A.8, × 40.

21

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23

PANNELL—AMERICAN CARBONIFEROUS FLORAS. IV

Explanation of Plate

PLATE 24

Fig. 24. *Lepidophloios* sp. from the Pyramid mine, Perry County, Illinois. WCB58B.9, × 5.

Fig. 25. *Lepidodendron scleroticum*, tangential section through leaf cushions. WCB91.6, × 5.

Fig. 26. *Lepidodendron Volkmannianum* (?) from Franklin County, Illinois. No. 1447, × 1.

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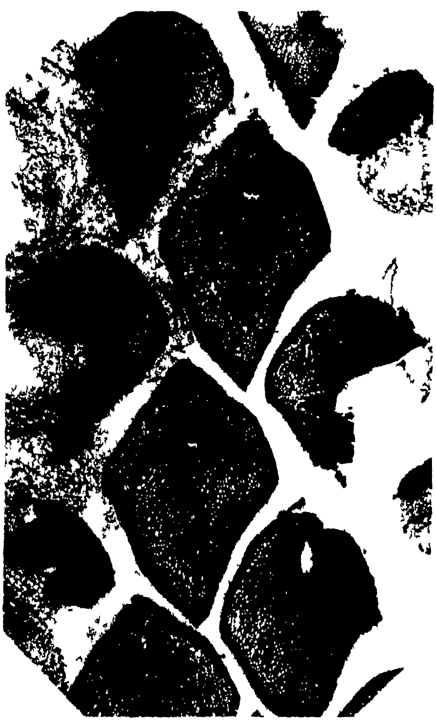

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PANNELL—AMERICAN CARBONIFEROUS FLORAS. IV

CONTRIBUTIONS TO OUR KNOWLEDGE OF AMERICAN CARBONIFEROUS FLORAS[1]

V. Heterangium

HENRY N. ANDREWS

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Assistant Professor, Henry Shaw School of Botany of Washington University

Our knowledge of Pteridosperm stem remains referred to the genus *Heterangium* is based chiefly on the earlier works of Williamson and Renault and the later detailed studies of Scott and Hirmer. Judging from its rather frequent occurrence in England, Scotland and on the Continent, the genus was well established throughout the greater part of the Carboniferous period.

Of the various plant organs that are assigned with some degree of certainty to the Pteridospermeae, *Heterangium* is of special significance because of its comparatively primitive structure as well as its occurrence in the early Calciferous Sandstone Series. It seems very likely that when its reproductive organs become better known we shall have a much clearer concept of how this early group of seed plants originated. An exhaustive review of the genus is unnecessary here inasmuch as the better-known species are adequately treated in certain of the standard texts and more detailed accounts may be found in the contributions of Scott ('17) and of Hirmer ('33). The latter work contains a useful key which outlines the major variations within the genus.

Although it has been known for some few years that *Heterangium* occurs in American Pennsylvanian coal-balls, no descriptions have been published. In 1935 Graham listed *H. tiliaeoides* as present in coal-balls from the McLeansboro horizon in Illinois, but his only comment relative to its occurrence was that, "Several stems were identified." In 1938 Fisher and Noé also reported *Heterangium* species from Calhoun coal-balls, but there were no accompanying descriptions. They also listed *H. Grievii* as having been found, which is rather surprising in view of its much earlier occurrence in the Calciferous Sandstone Series in Scotland. These brief references constitute, so far as I am aware, the only published accounts of the occurrence of the genus in America.

[1] Issued December 18, 1942.

Heterangium americanum, sp. nov.—

The following description is based on a number of stem and petiole remains found in coal-balls from the Calhoun coal, Richland County, Illinois. The locality is in the upper part of the McLeansboro formation and is of upper Pennsylvanian age. A single specimen of *Heterangium* has been collected by the author from the Herrin (No. 6) coal at the Pyramid Mine three miles south of Pinckneyville, Illinois. This constitutes the top of the Carbondale formation, and although it lies somewhat below the Calhoun coal (Schopf, '41, chart p. 9) this particular specimen is referable to *H. americanum*.

The specimens from Richland County consist of stem fragments bearing petioles, as well as isolated remains of both, and although the size and comparative development of secondary wood vary somewhat there are no distinctive features that necessitate segregation of the specimens into more than one species.

Primary Wood.—

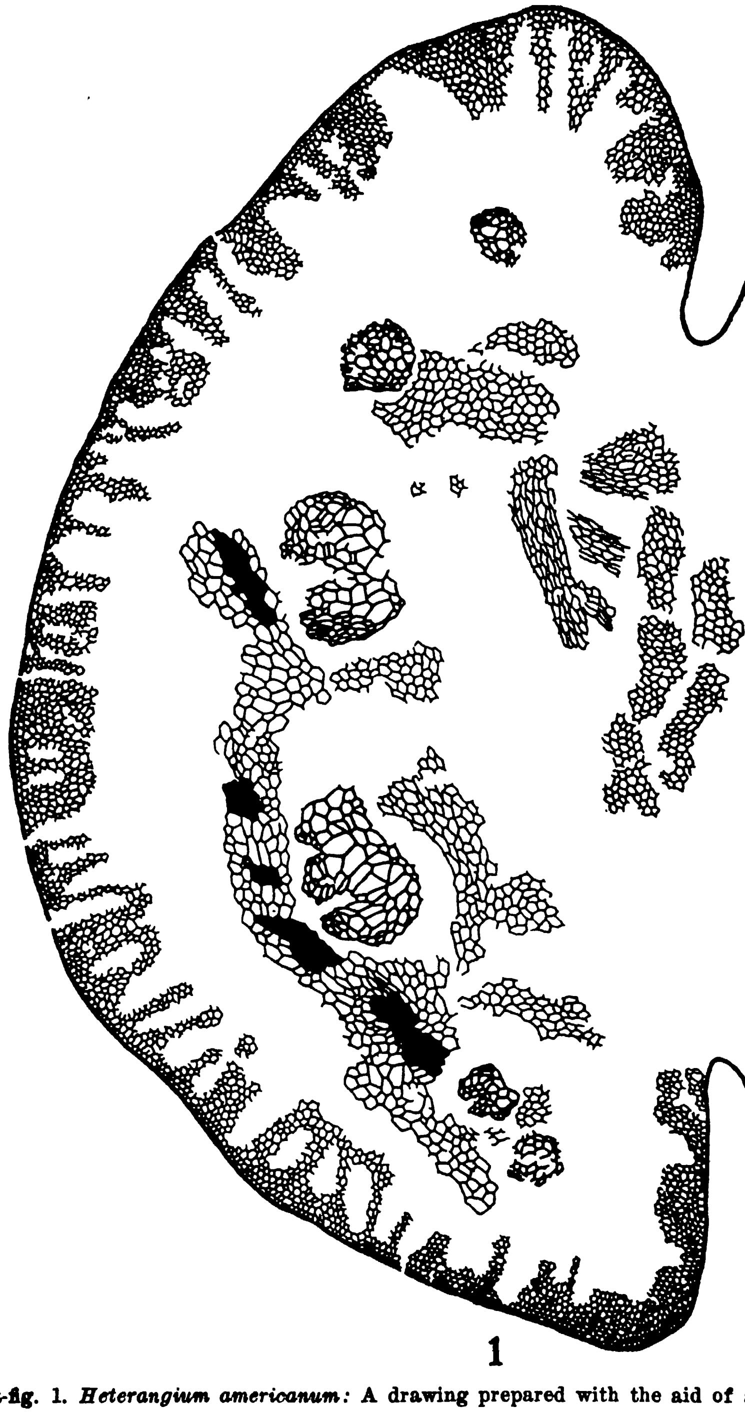
The diameter of the primary xylem varies in different specimens from 1.75 mm. to 4 mm. As in the European species of *Heterangium*, the protoxylem groups occupy a position very close to the periphery. Where it is possible to distinguish the protoxylem with certainty a few primary tracheids can be observed external to it although these pass almost imperceptibly into the secondary xylem. The protoxylem thus occupies an excentrically mesarch position though it is very close to being exarch.

The large metaxylem cells (pl. 25, fig. 3), which average about 260 μ in diameter, are uniformly distributed throughout the parenchyma of the central cylinder. They may occur singly or in small groups of 2, 3 or 4 cells, but usually not more than that number except in the peripheral region where they pass into the protoxylem. The tracheids of the latter may be as small as 15 μ in diameter, while the secondary tracheids average about 65 μ.

The pitting of the primary tracheids differs in no way from that described for other species.

Secondary Wood.—

Some of the stems exhibit no secondary growth at all, while others show as much as 5 mm. (figs. 1, 4). The wood rays vary greatly both in height and breadth as well as in the size of the component cells. Text-fig. 2, drawn with the aid of a camera-lucida, shows a representative tangential section. The rays may consist of but a



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Text-fig. 1. *Heterangium americanum:* A drawing prepared with the aid of a camera lucida showing division of the lateral and lobing of the central trace branches in a petiole. CB386.C.T11, × 17.5.

single row of cells while others are uniseriate but attain a height of 3 mm. or more. One such slender ray may be observed near the right-hand side extending the entire height of the figure. Elongate fusiform bi- or triseriate rays are common and may even reach a width of 6 or 7 cells although all of these broad rays that were observed were undergoing division.

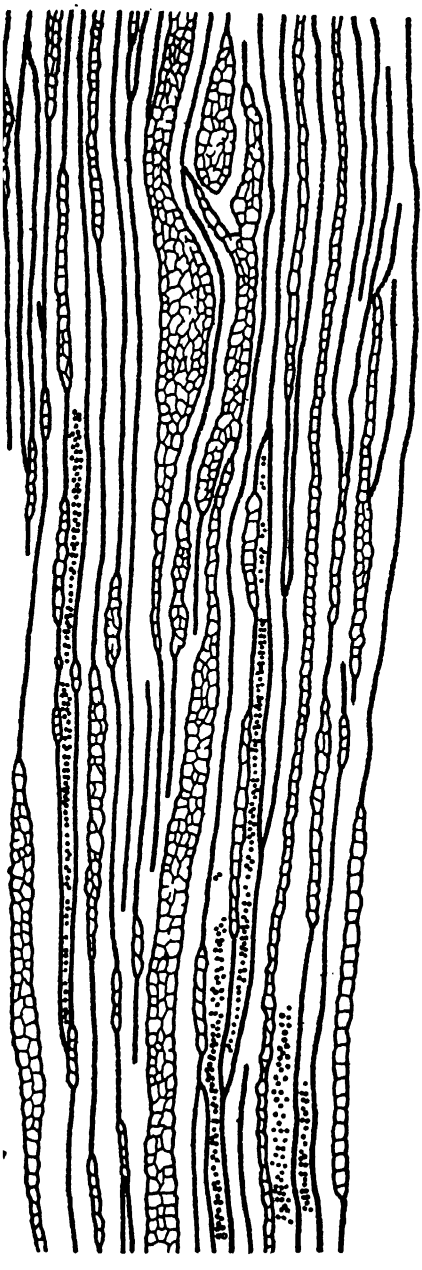
The radial walls of the tracheids are characterized by closely compacted angular pits (text-fig. 4) like those found in other species of *Heterangium,* as well as certain other probably closely related Pteridosperms such as *Lyginopteris, Rhetinangium* and *Stenomyelon.* The pit borders are not well preserved in the radial walls, but where they can be observed the orifice appears to be rather broadly oval-shaped and horizontally elongated.

The pits in the tangential walls are quite distinct from those in the radial walls, being nearly circular and loosely arranged in 1, 2 or 3 rows (text-fig. 3). The narrow orifice extends almost the entire diameter of the pit, and forms a cross with the pit in the wall of the adjacent tracheid.

Leaf Trace and Petiole.—

Owing to the fact that all the stems and petioles are short fragments, it has not been possible to follow any individual leaf trace from its origin in the stele out into the petiole. However, a sufficient number of specimens showed various stages in the course of the trace to give a reasonably complete picture of its anatomy.

The leaf trace originates from the periphery of the primary xylem as two distinct bundles about two mm. apart (text-fig. 5). They start to divide almost immediately and are two-lobed at the time of their departure from the stele. In their passage through the cortex the division is completed and four separate bundles enter the base of the petiole (fig. 2). The outer or lateral branches (fig. 2, L_1, L_2) resulting from the first division then divide into two small bundles which pass out toward the wing of the petiole (fig. 5, L_{1a}, L_{1b}; text-fig. 1). The two central bundles (fig. 2, c_1, c_2) resulting from the first division then start to divide into three bundles each (fig. 5; text-fig. 1). That this division began prior to the separation of the petiole from the stem is evidenced in text-fig. 1 which represents a petiole still connected to its stem. One of the large central bundles is clearly three-lobed while the other has not quite reached this stage. Another petiole found isolated (fig. 5) exhibits the three-lobed condition in both bundles. No specimens have been



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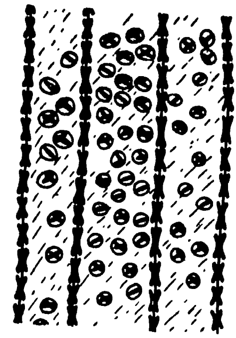

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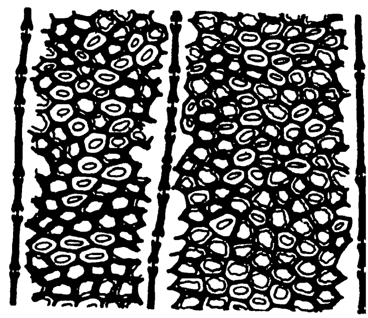

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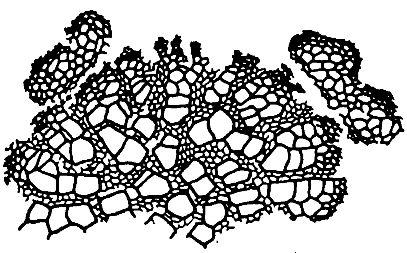

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Text-figs. 2–5. *Heterangium americanum:* fig. 2, tangential section through the secondary wood. CB542.B1.F48, × 62; fig. 3, pitting in the tangential walls of the secondary tracheids. CB542.B1.F48, × 265; fig. 4, pitting in the radial walls of the secondary tracheids. CB542.B1.F48, × 265; fig. 5, portion of a stele in transverse section showing the two traces that will enter a petiole. CB386.D2.T10, × 17.5.

found showing a higher level of the petiole than that illustrated in this figure. It seems very likely, however, that the two central strands soon divided, resulting in a total of ten at a slightly higher level. No evidence is available pertaining to the further division of the traces or the petiole as a whole.

Outside the bundles of the petiole shown in text-fig. 1 there may be noted a series of sclerotic nests embedded in large, thin-walled parenchymatous cells. The outer cortex is not well preserved, but judging from the more or less regular sequence of cavities (text-fig. 1) it seems likely that this zone consisted of alternate bands of fibrous and parenchymatous cells, the latter having decayed.

The extra-stelar tissues of the stems are not well preserved although specimen CB542 displayed the horizontal sclerotic plates characteristic of the outer cortex of the genus.

Diagnosis.—

Primary xylem from 1.75 to 4. mm. in diameter, metaxylem tracheids about 260 μ in diameter and uniformly distributed singly or in groups of 2, 3 or 4 cells; secondary wood well developed in some specimens, tracheids pitted on radial and tangential walls, rays variable in vertical and tangential dimensions; leaf trace double from the time of its origin, each trace dividing in its course through the cortex; of the four bundles entering the petiole the two central ones become three-lobed while the two marginal ones each divide to form two distinct bundles.

Locality and horizon: Richland County, Illinois; Calhoun coal, McLeansboro formation, upper Pennsylvanian and Herrin coal, Pyramid Mine, Perry County, Illinois; upper Carbondale formation.

All figured preparations are preserved in the Washington University collections, St. Louis. The original blocks and a representative set of preparations are deposited with the Illinois State Geological Survey.

Discussion.—

In his consideration of the British Coal-Measure Heterangiums Scott ('17) proposed the sub-genera *Eu-heterangium* and *Polyangium* to include those species characterized by having the vascular system of the petiole originate as a single or double bundle respectively. Hirmer ('33) recognizes six species in the *Polyangium* group, in which *H. americanum* belongs. The two German species,

H. Kukuki and *H. Hoppsteadteri*, differ rather strikingly from the Illinois *Heterangium* in the arrangement of the metaxylem tracheids. In the last they usually occur in 2- or 3-celled groups which are uniformly distributed. The contrast is especially true in *H. Kukuki*, where the tracheid cells are in large groups of 10 or more and the groups are separated by prominent parenchymatous "rays" (cf. Hirmer, '33, pl. 8, fig. 2).

The affinities of the Illinois species seem to lie close to the English *H. tiliaeoides* and *H. shorense*. Graham recognized this relationship when he assigned his specimen to the former. The small size of the metaxylem tracheid groups in *H. americanum* offers a character which likewise sets it apart from these English Heterangiums and which I believe is worthy in itself of specific distinction. Another feature, however, that has not been described for the other species is the apparent tri-partite branching of the central traces in the petiole (fig. 5). It may be, of course, that comparable portions of the petiole are present among the English specimens but until such is shown to be the case this may be considered as characteristic of *H. americanum*. In view of these differences it seems advisable to assign this new specific name to our specimens.

Acknowledgement.—

I wish to express my appreciation to the Illinois State Geological Survey, and especially to Dr. James M. Schopf of that organization, for the opportunity of studying and describing these American specimens of *Heterangium*.

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Explanation of Plate

PLATE 25

Heterangium americanum

Fig. 1. Slightly oblique transverse section showing well-developed secondary wood. CB542.A1.S13, × 8.5.

Fig. 2. Transverse section of a portion of a stem and attached petiole. CB386.D.T21; L_1, c_1 and L_2, c_2 are the branch traces resulting respectively from the two traces entering the petiole, × 8.5.

Fig. 3. Stele of same, × 12.

Fig. 4. A smaller stem showing secondary wood. CB323.A2.S9, × 8.5.

Fig. 5. An isolated petiole showing partial division of the central trace branches. CB323.A2.S9, × 8.5.

Photographs by Eloise Pannell.

ANDREWS—AMERICAN CARBONIFEROUS FLORAS. V

A FOSSIL ARAUCARIAN WOOD FROM WESTERN WYOMING[1]

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A few years ago the senior author made a collection of silicified woods from the Gros Ventre Canyon in western Wyoming. We were attracted to the region partly by some petrified log fragments on display outside the Jenny Lake Post Office, which were said to have been collected in the canyon, and partly by a landslide that presents a conspicuous scar on the lower end of the canyon, a landmark readily seen from the vicinity of Teton Park. Although two visits to the slide area failed to reveal anything of paleobotanical interest, certain regions farther up the canyon proved more productive. Approximately twelve miles up the road there is a second and considerably older slide now partially concealed by a fairly heavy vegetation. When this older landslide occurred the Gros Ventre Canyon was blocked and a lake formed in Cole Hollow.

At the time of our 1936 visit a petrified trunk some three feet in diameter was exposed approximately 200 yards from the south bank of the river. The slide area was subsequently followed up to its apparent origin, a point about one mile from the river (Mt. Leidy quadrangle, R 112 W, T 42 N). There, a small badlands area, some few acres in extent and light gray color, is quite prominent when viewed from the opposite side of the valley. Sections of silicified trunks and small twigs are comparatively abundant in the gullies, weathering out of rocks of Cretaceous age. A more precise determination of the horizon is not possible at present, since neither the stratigraphy nor paleontology of the region has been studied in detail.

Very small-scale coal-mining operations have been carried out on the opposite side of the river, likewise in Cretaceous strata. A seam some four feet thick outcrops about one-half mile north of the river and has been exploited in the past. The seam includes a number of bands of sandy clay some of which contain fern and dicot

[1] Issued December 18, 1942.

leaf impressions. However, the matrix is very friable near the surface, although it might be possible to obtain better specimens if deeper excavations were made.

The silicified woods in our collection include both dicotyledons and conifers. No attempt has been made to identify the former. The coniferous specimens include at least two distinct species. One of these is referable to *Cupressinoxylon* but, because of its otherwise indeterminate natural affinities, will not be considered, and the other can with reasonable certainty be placed in the Araucariaceae.

Araucarioxylon wyomingense sp. nov.—

Annual rings.—Present but indistinct, defined only by 2–3 rows of slightly thicker-walled summer cells (pl. 26, fig. 5).

Resin canals.—Absent.

Wood parenchyma.—Absent.

Wood rays.—Strictly uniseriate and mostly only 1–3 cells high (fig. 3); cross field pitting of the cupressoid type.[2]

Tracheids.—Quite constant in size throughout the annual ring, average 18 × 21 μ (tangential and radial dimensions respectively) in transverse section. Pitting uniseriate and biseriate, pits closely crowded and angular when biseriate (figs. 1, 2, 4, 6), crassulae absent, tangential pitting absent.

Type.—Slides 617, 623, and 631, radial, tangential, and transverse sections respectively, from a fragmentary specimen, Washington University, St. Louis.

The description is based on small fragments as well as a section of a trunk 9 inches in diameter and 5 inches long (No. 1396). Although this is the largest specimen in our collection it is a decorticated one and was evidently somewhat larger in life.

The most distinctive feature of the wood lies in the diminutive size of the rays. In a total of over 700 rays counted from four different slides 50 per cent were but one cell high, 28 per cent two cells high, 12 per cent three cells high, while only 10 per cent were more than three cells high. They present a striking appearance when viewed in tangential section as may be noted in fig. 3. This ray structure is quite distinct from that of any other described Araucarian wood and constitutes the chief basis of our specific designation. The supposed Araucarian relationships of the species are supported by the weakly defined annual rings, the cupressoid type cross field pitting and especially the tracheidal pitting.

[2] Phillips, E. W. J. The identification of coniferous woods by their microscopic structure. Jour. Linn. Soc. Bot. 52: 259–314. 1941.

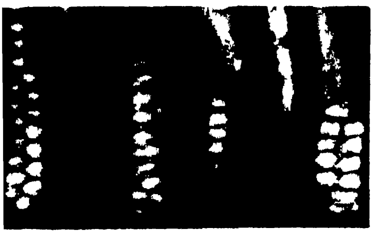
Explanation of Plate

PLATE 26

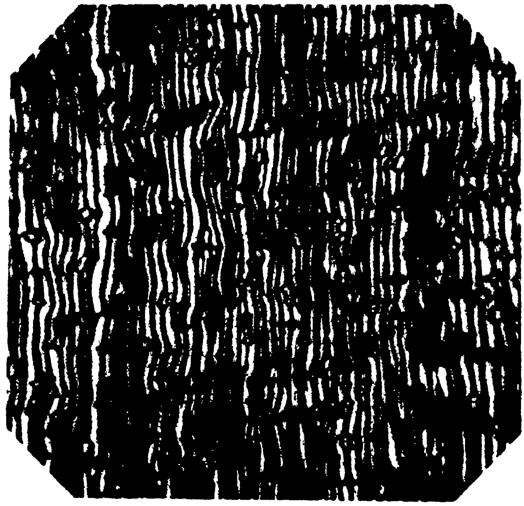
Araucarioxylon wyomingense

Figs. 1, 2, 4, 6. Pitting in the radial walls of the secondary tracheids. Slide 617, × 300.
Fig. 3. Tangential section. Slide 623, × 56.
Fig. 5. Transverse section. Slide 631, × 22.

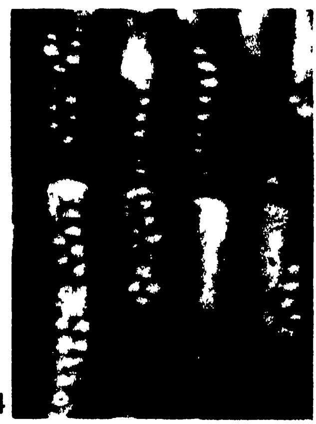
1



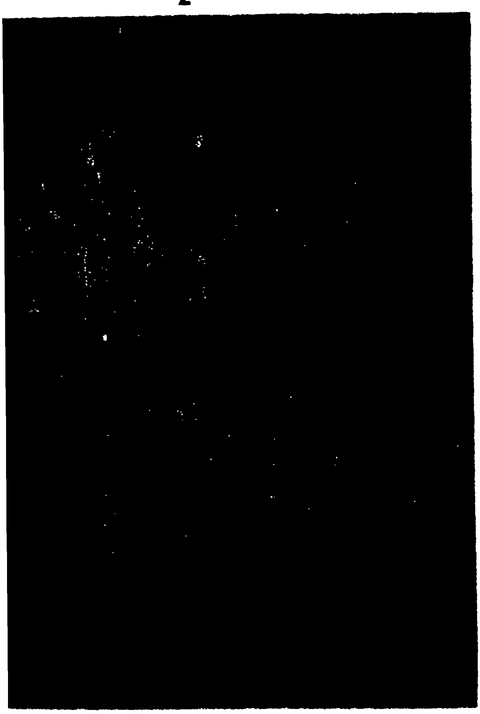
2



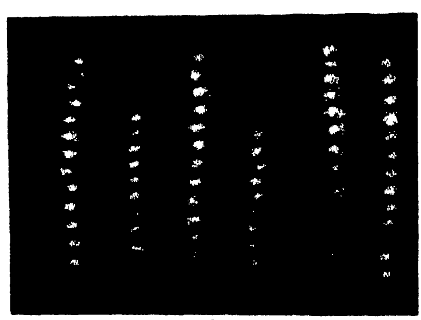
3



4



5



6

ANDREWS & PANNELL—FOSSIL ARAUCARIAN WOOD

MONOGRAPH OF SCHOENOCAULON[1]

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Introduction

Interest in a monographic treatment of the genus *Schoenocaulon*, a member of the Liliaceae, tribe Veratreae, was aroused by the state of taxonomic confusion into which it had fallen. Though the first plants of this genus were discovered more than a hundred years ago and more have been constantly collected since then, no monographic study has as yet been made of *Schoenocaulon*. From time to time new species were described which, in some cases, only increased the confusion. The problem resolved itself into a delimitation of the genus, a determination of the true generic name, the study of the morphological features which distinguish the species, and the geographical distribution of the genus as a whole and of the several species.

History of the Genus

The genus *Schoenocaulon* was first proposed by Asa Gray in 1837. It was based on *Helonias dubia* Michx. Michaux gave us the first description of the plant in 1803.[2] He had his doubts as to the genus when he designated some plants from Georgia and Florida as *Helonias dubia*. Willdenow,[3] Pursh,[4] Nuttall,[5] and others considered the species as doubtful *Helonias*. Later Gray made the segregation but called the plant *Schoenocaulon gracile*.[6]

Schiede and Deppe collected some plants on the eastern side of the Mexican Sierras. These were recorded by Schlechtendal and Chamisso as *Veratrum*, and in 1831 they proposed *Veratrum officinale* as a new species.[7] Hartweg found some more in the neighbor-

[1] A dissertation carried out in the Graduate Laboratories of the Henry Shaw School of Botany of Washington University and submitted as a thesis in partial fulfillment of the requirements for the degree of master of science in the Henry Shaw School of Botany of Washington University.

[2] Michx. Fl. Bor. Am. 1: 213. 1803.

[3] Willd. in Ges. Naturf. Freunde Berlin, Mag. 2: 29. 1808.

[4] Pursh, Fl. Am. Sept. 1: 244. 1814.

[5] Nuttall, Gen. N. Am. Pl. 1: 234. 1818.

[6] Gray, Ann. Lyc. N. Y. 4: 127. 1837.

[7] Schlecht. & Cham. in Linnaea 6: 45. 1831.

Issued December 18, 1942.

hood of Vera Cruz and sent them to the Royal Horticultural Society of London. Lindley had no doubt that these were the same as Schiede and Deppe's plants. However, he saw they were not of the genus *Veratrum* and proposed the name *Asagraea officinalis.*[8] No sooner had Dr. Gray seen the illustration and description of the plant than he realized that it belonged to his genus *Schoenocaulon.* Examination of Schiede and Deppe's specimen confirmed his opinion.[9] When in 1836 [1837] Brandt and Ratzeburg treated *Veratrum officinale*[10] they inserted a footnote calling this plant *Sabadilla officinarum,* but they used *Sabadilla* as a subgeneric name in their main description.

The next species appeared in literature in 1838 when Schlechtendal described an Ehrenberg specimen as *Veratrum caricifolium.*[11] Six years later Schlectendal tried to correct his generic designation and change the name to *Sabadilla caricifolia.*[12] But he was too late, for Gray in 1840 had examined the same specimens and rightfully called them *Schoenocaulon caricifolium.*[13]

Schoenocaulon Drummondii was described by Gray in 1840, from a plant in Drummond's Texas collection.[14] The species *Schoenocaulon tenuifolium* was first called *Veratrum tenuifolium* by Martens and Galeotti in 1842,[15] and *Asagraea tenuifolia* by Kunth a year later.[16] Robinson and Greenman made the proper combination in 1895.[17]

Lindheimer collected Texas plants in the spring of 1846 and sent them to Scheele who called no. 543 *Schoenocaulon texanum.*[18] From this description Gray mistook the plant for his *S. Drummondii* and reduced *S. texanum* to synonymy.[19] These two species were continually confused until 1916, when Pennell pointed out their several points of difference.[20]

Schoenocaulon Coulteri is the name given by Baker in 1879 to a

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[8] Lindl. in Edwards' Bot. Reg. **2**: *t.33.* 1839.

[9] Gray in Hook. & Arn. Bot. Beechey's Voy. 388. 1840.

[10] Brandt & Ratzeb. in Hayne, Darstel. v. Beschreib. d. Arzneig. **13**: *t.27.* 1836. [1837].

[11] Schlecht. in Ind. Sem. Hort. Hal. 8. 1838.

[12] Schlecht. in Linnaea **18**: 444. 1844.

[13] Gray in Hook. & Arn. Bot. Beechey's Voy. p. 388. 1840.

[14] Gray in Hook. & Arn. Bot. Beechey's Voy. 388. 1840.

[15] Mart. & Gal. in Acad. Roy. Brux. Bul. **9**[2]: 380. 1842.

[16] Kunth, Enum. Pl. **4**: 700. 1843.

[17] Robins. & Greenm. in Am. Jour. Sci., III, **50**: 168. 1895.

[18] Scheele in Linnaea **25**: 262. 1852.

[19] Holographic notes of Dr. A. Gray, in Libr. Mo. Bot. Gard.

[20] Pennell in Bull. Torrey Bot. Club **43**: 408. 1916.

plant which Coulter found near Zimapan, Mexico.[21] Hemsley[22] and Kuntze[23] have the only other references in literature to this plant. Greenman described the next species, *S. Pringlei,* in 1897[24]; and *S. calcicola, S. Ghiesbreghtii* and *S. jaliscense* in 1907.[25] The most recent description is that of *S. megarhiza* by Marcus E. Jones in 1912.[26]

Schoenocaulon intermedium has had a career of confusion ever since its description by Baker in 1879.[27] Various plants have been placed in and taken out of the species. The original description was too general and the type specimens so poor that no definite idea of the real species could be formed. Evidence seems to point to the correctness of Hemsley's statement that "probably *S. intermedium* may not be a distinct species"[28] and should be reduced to synonymy under *S. texanum.*

Morphology

The bulb of *Schoenocaulon* is generally egg-shaped and covered with either dark, thin, dry scales, as in *S. Drummondii* and *S. dubium,* or, as is more common, by a tangle of fibers. The fibers are the fibro-vascular bundles which persist after the mesophyll of the first leaf-bases has decomposed. In young plants these fibers are not thickly coated over the bulb and around the base of the leaves, but in plants several years old they show specific characters in the density, color and texture. Some species, for example *S. jaliscense,* have fine and rather soft fibers, while others, as *S. comatum,* are characterized by coarse and stiff fibers forming mats which resemble hanks of horsehair.

The grass-like leaves are all basal and afford specific characters as to length and breadth only when the average can be taken from a number of full-grown plants. The intergradation between a short leaf of a long-leaf species and an unusually long leaf of a short-leaf species makes leaf characters quite unsatisfactory for classification. As to number of veins in a leaf, it has been found impossible to use the character of venation with any degree of satisfaction.

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[21] Baker in Jour. Linn. Soc. Bot. 17: 477. 1879.
[22] Hemsl. in Salvin & Godman, Biol. Cent.-Am. Bot. 3: 383. 1885.
[23] Kuntze, Rev. Gen. Pl. 2: 713. 1891.
[24] Greenm. in Proc. Am. Acad. 32: 295. 1897.
[25] Greenm. in Proc. Am. Acad. 43: 19–20. 1907.
[26] Jones, Contr. West. Bot. 14: 29. 1912.
[27] Baker in Jour. Linn. Soc. Bot. 17: 477. 1879.
[28] Hemsley in Salvin & Godman, Biol. Cent.-Am. Bot. 3: 382. 1885.

Extreme cases of narrowness or breadth, as in *S. tenue* and *S. officinale* respectively, coupled with other features, may be of value in determining some of the species.

The scape is always naked, straight, and terete above. Usually the base is somewhat angled because of the pressure exerted on it in the bulb.

Some of the most valuable diagnostic features are to be found in the inflorescence, particularly its length and its diameter at anthesis. Other points to be noted are the disposition and spacing of the flowers on the axis, whether evenly or irregularly placed, whether crowded or distant from each other. In some species, as *S. regulare,* the flowers are all uniform in position and mature simultaneously. Other species, as *S. texanum* or *S. officinale,* have the lowermost flowers fruiting before those at the tip of the spike shed their pollen.

The six perianth segments are, with the exception of *S. Conzattii, S. Ghiesbreghtii, S. Pringlei,* and *S. tenuifolium,* about 2–3 mm. in length. *Schoenocaulon tenuifolium* is the only species with broadly ovate perianth-segments. All the other species have either ligulate or narrowly ovate segments. It is the margins of the segment which affords the most valuable character for specific determination. *Schoenocaulon Drummondii, S. tenuifolium* and *S. yucatanense* are erose-margined; *S. comatum, S. dubium,* and *S. officinale* are entire-margined; the majority of the species have a single hyaline tooth projecting from the sides of the segment near the base; others, such as *S. Ghiesbreghtii,* have two teeth on each margin. *Schoenocaulon Pringlei* is subscarious-margined and *S. caricifolium* is subdentate-margined. In all species, except *S. officinale,* the nectary gland is too inconstant and inconspicuous a character to be of much value.

The hypogynous stamens are six in number with large, reniform, single-celled anthers. In most species the filaments are twice the length of the perianth, while in *S. megarhiza, S. obtusum,* and *S. Pringlei* they scarcely project at all, and *S. yucatanense* has filaments three times as long as the perianth.

The mature fruit of most of the species is ovoid and somewhat inflated. *Schoenocaulon macrocarpum* has a capsule which is more linear than oval; that of *S. caricifolium* and *S. tenuifolium* shows marked inflation. The former has a regular oval shape, whereas the latter is obovate.

The seeds, if mature and obtained in sufficient abundance, may perhaps furnish added traits for determination of the species.

Economic Importance

The entire plant is poisonous, particularly the seeds, which are without odor but have an acrid burning taste. The medicinal virtue of the seed is due to the alkaloid veratrine. Tinctures, extracts, and powders were once made from the seeds and used for rheumatism, paralysis, cardiac conditions, dropsy, and as a taenicide. Because it is such a drastic purgative and productive of such severe vomiting and internal bleeding it has been discarded as a remedy in internal medicine. Several deaths from its employment have been recorded. Its use nowadays is restricted to veterinary medicine or for destroying body lice and other vermin. Specimens received recently from H. S. Gentry bear the following notation concerning the plants he collected in Sinaloa, Mexico: "Roots employed for killing maggots in wounds; powdered and applied or decocted as a wash."

Related Genera

Schoenocaulon has been confused with several genera, particularly *Helonias*, *Veratrum*, *Tofieldia*, and *Zygadenus*. The following tabulation will furnish some salient morphological features useful in distinguishing *Schoenocaulon* from related genera.

Schoenocaulon:	Base of plant a fibrous-tunicate bulb; leaves basal, narrow; scape simple; flowers disposed in a spike or dense raceme; perianth-segments glandular or eglanular.
Helonias:	Base of plant a short tuberous root-stock; leaves basal, broad and fleshy; scape simple; flowers disposed in a raceme; perianth-segments not glandular.
Veratrum:	Base of plant a fibrous-tunicate bulb; leaves cauline, broad; inflorescence a dense terminal panicle; perianth-segments not clawed, eglandular.
Tofieldia:	Base of plant a short creeping rhizome; leaves 2-ranked, equitant; flowers disposed in a dense raceme or spike; perianth-segments not clawed.
Zygadenus:	Base of plant a rhizome or a tunicated bulb; leaves basal, linear; scape branched; flowers disposed in an open panicle; perianth-segments glandular, distinctly clawed.

Geographical Distribution

Schoenocaulon has been found in the southernmost parts of the United States, in Mexico, Central America, and in two states of South America.

Schoenocaulon dubium is the only Floridan species. *S. Drummondii* and *S. texanum* are found in Texas and northern Mexico. The latter species grows as far north as the southeastern counties of New Mexico. The widest distributed species is *S. officinale,* having been collected in Mexico, throughout Central America, and in parts of Venezuela and Peru.

The paucity of specimens makes an adequate distribution picture of the genus *Schoenocaulon* impossible. Those states of Mexico and Central America which have been more extensively botanized have contributed a greater number of species. Gaps between localities where such species as *S. comatum* and *S. regulare* are found indicate the need of more field work and collecting.

Common Names

Schoenocaulon has a number of common names, such as: Green Lily (Texas), Feather-shank (Florida), Sabadilla, Sabadille, Cebadilla, Cevadille, Cevadilha, Matu Curros, Semen Sabadillae, Sabadillsamen, Capuziner Samen, Laeusekraut, Mexicanischer Laeusesamen and several others.

Abbreviations

Sincere appreciation is expressed to all those institutions whose cooperation and facilities have made this work possible. The herbaria cited in this monograph are indicated by the following abbreviations:

CA—California Academy of Sciences.
D—Dudley Herbarium of Stanford University.
F—Field Museum of Natural History.
G—Gray Herbarium of Harvard University.
M—Missouri Botanical Garden.
P—Pomona College.
PA—Academy of Natural Sciences of Philadelphia.
UC—University of California, Berkeley.
US—United States National Herbarium.

Taxonomy

Schoenocaulon Gray in Ann. Lyc. N. Y. 4: 127. 1837; Endl. Gen. Pl. 1357. 1840; Meisn. Pl. Vasc. Gen. 1: 405. 1836-43; Kunth, Enum. Pl.

4: 185. 1843; Chapm. Fl. South. U. S., 490. 1860; Baker in Jour. Linn. Soc. Bot. **17**: 476. 1879; Benth. & Hook. f. Gen. Pl. **3**: 836. 1880; Hemsl. in Salvin & Godman, Biol. Cent.-Am. Bot. **3**: 383. 1885; Engl. & Prantl, Nat. Pflanzenfam. **II**. 5: 23. 1888; Small, Fl. Southeast. U. S. 250. 1903, and ed. 2, 1913; Small, Man. Southeast. Fl., 277. 1933.

Veratrum Schlecht. & Cham. in Linnaea **6**: 45. 1831, not L.

Helonias Don in Edinb. N. Phil. Jour. 234. 1832, not L.

Sabadilla[29] Brandt [Brandt & Ratzeburg] in Hayne, Arzneig. **13**: *t. 27*. 1836 [1837], as subgenus; Schlecht. in Linnaea **18**: 444. 1844, as genus; Kuntze, Rev. Gen. Pl. **2**: 713. 1891; Dalla-Torre & Harms, Gen. Siph. 60. 1900–1907; Engl. & Prantl. Nat. Pflanzenfam. ed. 2, **15a**: 261. 1930.

Skoinolon Raf. Fl. Tellur. **4**: 27. 1836, nomen prius.

Asagraea Lindl. in Edwards' Bot. Reg. **2**: *pl. 33*. 1839; Hook. & Arn. Bot. Beechey's Voy. 388. 1840; Kunth, Enum. Pl. **4**: 184. 1843; A. Rich. in Orb. Dict. **2**: 199. 1845; Spach in Hist. Nat. Veg. Phan. **12**: 245. 1846, not *Asagraea* Baill. in Adansonia **9**: 233. 1870.

DESCRIPTION OF THE GENUS

Herbaceous perennials; bulb oblong to ovoid; basal portion of the plant surrounded by a cylindrical covering of brownish-black to black scales and fibers, the remnants or the first bulb-scales and outer leaves; leaves all basal, grass-like, long and narrow, attenuate into a hair-like tip, flat, coarsely and strongly nerved, firm in texture, glabrous on both sides, slightly or not at all glaucous, margins serrulate; scape erect, simple, naked, glabrous, glaucous and terete above, purplish and angled below; spike virgate, many-flowered, bracteate, terminal portion bearing sterile flowers; bracts small, solitary, partly clasping the axis, broad-triangular or deltoid, rounded or acuminate-tipped, thin, scarious, dull hyaline, erose-margined; flowers perfect, at first crowded, later more or less scattered, regular, small, erect, sessile or on short stout pedicels, base

[29] Brandt and Ratzeburg, in 1836 [1837], in Hayne's 'Darstellung und Beschreibung der Arzneigewächse,' recognized *Veratrum officinale* Schlecht. as a valid name and described and illustrated this plant in detail. *Sabadilla* was definitely included as a subgenus of *Veratrum*. In a footnote they suggested the possible binominal *Sabadilla officinarum*. This name, however, is accompanied by the following statement. "Es schien uns daher besser, für jetzt ein Subgenus! unter dem Namen *Sabadilla* vorszuschlagen, um jene auffallenden Eigenthümlichkeiten anzudeuten." Since *Sabadilla* was here placed in the rank of subgenus it cannot, according to the International Rules of Botanical Nomenclature, supersede the generic name of *Schoenocaulon* Gray which was validly published in 1837.

broadly bell-shaped to hemispherical, pale green to yellowish-white; perianth-segments 6, hypogynous, cyclic, subequal, sessile, free or scarcely united at the base, somewhat spreading, persistent, faintly 3–5-nerved, leathery to scarious, obtuse, oblong to narrowly linear, entire, subentire, 1–2-dentate on either margin, or erose, often hyaline-margined, glandular or eglandular; stamens 6, hypogynous, subequal, inserted at the base of the perianth-segments, persistent, erect; filaments filiform, yellow to purplish-red, awl-shaped, at first short, later elongating, recurved; anthers large, versatile, yellow, reniform before dehiscence, later clypeolate or peltate, unilocular, extrorse; ovary ovoid, constricted at the base, superior, free from the perianth and stamen-cycle, tricarpellary; ovules 6–8 in each cell, biseriate, axillary, ascending, anatropous; styles 3, distinct, divergent, slightly recurved, short, tapering to the apex; stigma terminal, simple, minute; capsule ovoid to oblong, acuminate, chartaceous, glaucous, persistent, 3-celled, septicidally dehiscent, pedicels when present stout, recurved or ascending; seed ovate to slender-oblong, nearly terete, often curved, slightly winged at the apex, coat corrugated, dark brown and shiny, 1–5 superposed and compressed in each cell, albumen firm, embryo minute, near the hilum.

Type species: **Schoenocaulon dubium** (Michx.) Small, Fl. Southeast. U.S., 250. 1903 (*S. gracile* Gray in Ann. Lyc. N. Y. **4**: 127. 1837).

KEY TO THE SPECIES

A. Perianth-segments ligulate, margins not toothed; nectaries prominent............ ....*14. S. officinale*
AA. Perianth-segments ligulate to ovate, margins with or without teeth; nectaries absent or not prominent............B
B. Inflorescence 15–20 mm. in diameter............C
C. Perianth-segments ovate, 3 mm. broad............*18. S. tenuifolium*
CC. Perianth-segments ligulate, 1 mm. broad............D
D. Perianth-segments with erose margins............*6. S. Drummondii*
DD. Perianth-segments with entire or with few-toothed margins............E
E. Flowers crowded on the spike............*8. S. Ghiesbreghtii*
EE. Flowers loosely disposed on the spike............*4. S. Conzattii*
BB. Inflorescence 5–15 mm. in diameter............C
C. Perianth-segments with erose margins............*20. S. yucatanense*
CC. Perianth-segments not erose-margined............D
D. Perianth-segments obscurely or not at all dentate, not scarious-margined...E
E. Bulb covered with coarse stiff fibers; scape 15–30 cm. long............F
F. Scape 15–17 cm. long; capsules strongly inflated....*2. S. caricifolium*
FF. Scape 18–30 cm. long; capsules not strongly inflated....*3. S. comatum*
EE. Bulb covered with scales or fine fibers; scape 30 cm. or more long.......F
F. Spike narrow, 5–8 mm. in diameter............*7. S. dubium*
FF. Spike wider, 10–15 mm. in diameter............*19. S. texanum*
DD. Perianth-segments distinctly dentate or scarious-margined............E

E. Leaves narrow, 0.5–2.5 mm. wide .... F
F. Flowers crowded on the axis; capsules 10–12 mm. long .. *15. S. Pringlei*
FF. Flowers distantly disposed on the axis; capsules 8–10 mm. long .... *17. S. tenue*
G. Spikes 4–10 cm. long, 10 mm. in diameter .... *17. S. tenue*
GG. Spikes 1.5–6 cm. long, 13–14 mm. in diameter .... *5. S. Coulteri*
EE. Leaves broader, 2–8 mm. wide .... F
F. Scape 85–150 cm. long .... G
G. Spike 30–40 cm. long .... *9. S. jaliscense*
GG. Spike 14–23 cm. long .... *12. S. Mortonii*
FF. Scape 25–75 cm. long .... G
G. Flowers all uniform in size and disposition on the axis .... H
H. Filaments scarcely projecting beyond the perianth; capsules numerous, 5–7 mm. in diameter, closely imbricated and appressed to the axis .... *13. S. obtusum*
HH. Filaments twice the length of the perianth-segments; capsules few, 4–5 mm. in diameter, small and distantly placed on the axis, not imbricated or appressed to the axis .... *16. S. regulare*
GG. Flowers of different sizes and irregularly disposed on the axis ...... H
H. Fruit reflexed .... *1. S. calcicola*
HH. Fruit not reflexed I
I. Leaf 3–6 mm. broad; scape 40–60 cm. long; flowers subsessile .... *11. S. megarhiza*
II. Leaf 2–3 mm. broad; scape 30–45 cm. long; flowers pedicelled .... *10. S. macrocarpum*

1. Schoenocaulon calcicola Greenm. in Proc. Am. Acad. **43**: 19. 1907.

Bulb ovoid, 1.5–3 cm. in diameter; basal portion of the plant covered with coarse black fibers extending to a height of 5–14 cm.; leaves thin, 3–10 dm. long, 2–4 mm. broad; scape 5.5–7.5 dm. long, slender, somewhat flexuous, purplish toward the base; spike 8–23 cm. long, 8–10 mm. in diameter, the flowers loosely and irregularly disposed on the axis, small, sessile, short-pedicelled; perianth-segments slender, 2.5–3 mm. long, bearing a single tooth on each margin; filaments twice the length of the perianth; capsule oblong-lanceolate, 8–10 mm. long, 5 mm. in diameter, reflexed; 2–3 seeds in each cell.

MEXICO—OAXACA: Las Sedas, calcareous banks, alt. 1830 m., 19 July 1897, *Pringle 6740* (G, M, NY, PA, UC, US); hillsides, alt. 1830 m., 1 Aug. 1894, *Pringle 5754* (G TYPE, US).

2. Schoenocaulon caricifolium (Schlecht.) Gray in Hook. & Arn. Bot. Beechey's Voy. 388. 1840; Wats. in Proc. Am. Acad. **14**: 281. 1879, excluding *Coulter 1568;* Hemsl. in Salvin & Godman, Biol. Cent.-Am. Bot. **3**: 383. 1885 in part; Greenm. in Proc. Am. Acad. **43**: 19. 1907, excluding *Conzatti & Gonzalez 323.*

Veratrum caricifolium Schlecht. in Ind. Sem. Hort. Hal. 8. 1838; in Linnaea Litt. Ber. **13**: 100. 1839.

Asagraea caricifolia Kunth, Enum. Pl. **4**: 666. 1843.

Sabadilla caricifolia Schlecht. in Linnaea **18**: 444. 1844.

Bulb 15–25 mm. in diameter; base of the plant covered for 7–17 cm. with dark brown, stiff fibers; leaves narrow, flexuous, 3–3.5 dm. long, 1–3 mm. broad; scape stout, short, 15–17 cm. long; spike short and narrow, 4–6 cm. long, 10 mm. in diameter; flowers small and crowded on the axis; perianth-segments obscurely subdentate, oblanceolate, 3 mm. long; capsule broadly ovate, inflated, 15 mm. long, 10 mm. in diameter, compacted into a fruiting spike 3.5 cm. in diameter; seed 6–7 mm. long, 1–3 in each cell.

MEXICO—COAHUILA: "mountain borders," near Saltillo, 25 June 1848, *Gregg 214* (G, M). HIDALGO: near los Baños de Atotonilco el Grande, calcareous mountains, Oct. and Dec., *Ehrenberg* (G TYPE, NY, P). OAXACA: near City of Oaxaca, 16–21 June 1899, *Rose & Hough 4972* (US); Cerro Verde, Aug. 1908, *Purpus 4389* (UC).

3. **Schoenocaulon comatum** Brinker, n. sp.[30]

Bulb ovoid, 1.5–3 cm. in diameter; base of the plant covered for 8–26 cm. with a thick cylinder of blackish, coarse, stiff fibers; leaves longer than the scape, straight, as much as 6 dm. long and 2–4 mm. broad; scape 18–30 cm. long, erect, purplish toward the base; spike loosely flowered, attenuate, 3.5–15 cm. long, 7–12 mm. in diameter at anthesis; flowers small, subsessile; perianth-segments entire-margined, 2–3 mm. long, ligulate; filaments thin, twice as long as the perianth; mature capsule ovate-oblong, chartaceous, erect, inflated, 10–13 mm. long, 6–7 mm. in diameter; pedicel of the fruit 3–4 mm. long; 2–3 seeds in each cell.

MEXICO—SAN LUIS POTOSI: Valley of San Louis Potosi, San Miguelito Mts., coll. of 1876–1878, *Schaffner 536* (PA, G, NY); without definite locality, *Schaffner 228* (CA, NY TYPE, P, PA, UC, US); region of San Luis Potosi, alt. 1830–2440 m., coll. of 1878, *Parry & Palmer 882* (G, M, PA, US); Charcas, July-Aug. 1934, *Whiting 523* (D, NY, US). PUEBLA: Cerro de Mazize, moist soil, July 1907, *Purpus 2731* (UC); vicinity of San Luis Tultitlanapa, June 1908, *Purpus 2731* (G, NY, M, US). OAXACA: Canada de San Gabriel, Etla, alt. 300 m., 8 Aug. 1897, *Conzatti & Gonzales 323* (G).

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[30] **Schoenocaulon comatum** sp. nov. Bulbus ovoideus, 1.5–3 cm. diametro; caudice cylindro, 7–26 cm. longo, fibris nigrescentibus crassis rigidis dense obtecto; foliis scapo longioribus, rectis, usque ad 6 dm. longis, 2–4 mm. latis; scapo 18–30 cm. longo, erecto, basin versus purpureo; spica laxiflora, attenuata, 3.5–15 cm. longa, anthesi 7–12 mm. diametro; floribus parvis, subsessilibus; perianthii segmentis integris, 2–3 mm. longis, ligulatis; filamentis tenuibus, perianthio duplo longioribus; capsulis maturis ovato-oblongis, chartaceis, erectis, inflatis, 10–13 mm. longis, 6–7 mm. diametro; pedicello fructus 3–4 mm. longo; seminibus in loculo 2–3.

4. Schoenocaulon Conzattii Brinker, n. sp.[31]

Bulb ovoid, 1.5–2 cm. in diameter; base of the plant covered for 7–23 cm. with a dense sheath of dark brown, coarse fibers; leaves 6–11 dm. long, 4–7 mm. broad; scape 5–7 dm. long; spike 10–25 cm. long, 15–17 mm. in diameter; mature flowers loosely disposed, erect, shortly pedicelled; perianth-segments with a single tooth on each margin, linear-lanceolate, 3.5–4 mm. long; filaments twice or three times as long as the perianth; immature capsule 8 mm. long, 4 mm. wide, imbricated, pedicel arched and 3–4 mm. long; 4–5 seeds in each cell.

MEXICO—HIDALGO: Sierra de Pachuca, alt. 2981 m., 1 Sept. 1906, *Pringle 13841* (G, US). STATE OF MEXICO: Temascaltepec, Rincon del Carmen, woods, alt. 1340 m., 23 Nov. 1932, *Hinton 2690* (NY); Nanchititla, oak woods, 8 Oct. 1933, *Hinton 4970* (G, M, NY). OAXACA: Cerro de San Felipe, alt. 2000 m., 29 Aug. 1897, *Conzatti & Gonzales, 449* (G, US TYPE). PUEBLA: Boca del Monte, moist grassy soil, June 1907, *Purpus 2490* (UC).

5. Schoenocaulon Coulteri Baker in Jour. Linn. Soc. Bot. **17**: 477. 1879; Hemsl. in Salvin & Godman, Biol. Cent.-Am. Bot. **3**: 382. 1885; Coulter in Contr. U.S. Nat. Herb. **2**: 440. 1894 (Bot. West. Texas), as to name only.

Sabadilla Coulteri Kuntze, Rev. Gen. Pl. **2**: 713. 1891.

The only specimen available for examination comprises fragments of leaf tips and parts of flowering stalks. The spikes measure 1.5–6 cm. in length and 13–14 mm. in diameter; the flowers are erect, somewhat loosely set on the axis of the inflorescence; perianth-segments leathery, with a single tooth on each margin, 3 mm. long; filaments reflexed, twice the length of the perianth, anthers small, globular.

MEXICO—HIDALGO: near Zimapan, *Coulter 1569* (G ISOTYPE).

6. Schoenocaulon Drummondii Gray in Hook. & Arn. Bot. Beechey's Voy. 388. 1840; Torrey in Bot. U.S. & Mex. Bound. Surv. **2**: 222. 1859, in part, excluding Pl. Lindh.; Wats. in Proc. Am. Acad. **14**: 281. 1879; Baker in Jour. Linn. Soc. Bot. **17**: 477. 1879, in part, excluding *Lindheimer 543, 711;* Wats. in Proc. Am. Acad. **18**: 166.

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[31] **Schoenocaulon Conzattii** sp. nov. Bulbus ovoideus, 1.5–2 cm. diametro; caule fibris densis atrobrunneis crassis ad 7–23 cm. dense obtecto; foliis 6–11 dm. longis, 4–7 mm. latis; scapo 5–7 dm. longo; spica 10–25 cm. longa, 15–17 mm. diametro; floribus maturis laxe dispositis, erectis, breviter pedicellatis; perianthii segmentis utraque margine dente unico, lineari-lanceolatis, 3.5–4 mm. longis; filamentis duplo vel triplo perianthio longioribus; capsulis immaturis 8 mm. longis, 4 mm. latis, imbricatis, pedicello arcuato, 3–4 mm. longo; seminibus in cellulo 4–5.

1883, in part, as to *Palmer 1322* only; Hemsley in Salvin & Godman, Biol. Cent.-Am. Bot. **3**: 382. 1885 in part, as to name only; Small, Fl. Southeast. U.S. 250. 1903.

Schoenocaulon aletroides Gray in Hook. & Arn. Bot. Beechey's Voy. 388. 1840.

Sabadilla Drummondii Kuntze, Rev. Gen. Pl. **2**: 713. 1891.

Bulb ovoid, 2–3.5 cm. in diameter; base of the plant covered with thin scales and few fibers for 5–12 cm.; leaves 2–5 dm. long, 1.5–5 mm. broad; scape 2.5–6 dm. long; spike dense, 3–20 cm. long, 15–20 mm. in diameter; flowers subsessile; perianth-segments oblong-ovate, 3 mm. long, 1 mm. broad, nearly membranaceous, with broad scarious, erose margins; filaments stout, subclavate-filiform, much dilated above, 5–7 mm. long; flowering in autumn.

Distribution: southwestern United States and Mexico.

UNITED STATES:

TEXAS—BEE CO.: ½ mi. s. of Tuleta, 21 Sept. 1936, *Cory 20644* (G). BEXAR CO.: San Antonio, Oct. 1837, *Riddell* (US). COLORADO CO.: 3 mi. e. of Alleyton, sandy soil, 22 Sept. 1913, *Pennell 5557* (NY). DE WITT CO.: roadside near Yorktown, 6 Oct. 1857, *Schott* (NY). DUVAL CO.: 25.6 mi. n.w. of San Diego, 9 Oct. 1935, *Cory 16146* (G). GOLIAD CO.: near Goliad, open prairie, 7 Oct. 1926, *Williams 91* (PA). GUADALUPE CO.: Seguin, limestone soil, 22 Aug. 1903, *Groth 202* (CA, G, NY, US). SAN PATRICIO CO.: s. of Mathis, 20 Oct. 1927, *Rose & Russell 24160* (US). WILSON CO.: Sutherland Springs, Aug. 1879, *Palmer 1322* (G). WITHOUT DEFINITE LOCALITY: coll. of 1880, *Palmer 1322* (US); Valley of the Rio Grande, below Donana, *Parry, Bigelow, Wright & Schott 1482* (US); *Drummond I 284* (G); *Drummond III 284* (NY TYPE); 1 Oct. 1935, *Parks* (G); 1840, *Riddell 52* (NY); 188–, *Schlottmann* (US).

MEXICO—SAN LUIS POTOSI: San Dieguito, 13–16 June 1904, *Palmer 119* (G, M, NY, US); Tamazunchale, Cerro de S. Francisco, 11 May 1891, *Manry 6257* (G).

7. **Schoenocaulon dubium** (Michx.) Small, Flora Southeast. U.S. 250. 1903, and ed. 2, 1913; Small, Man. Southeast. Fl. 277. 1933.

Helonias dubia Michx., Fl. Bor. Am. **1**: 213. 1803; Willd. in Ges. Naturf. Freunde Berlin Mag. **2**: 29. 1808; Poiret in Lamarck, Encycl. Meth. Bot. Suppl. **3**: 28. 1813; Pursh, Fl. Am. Sept. **1**: 244. 1814; Nutt. Gen. N. Am. Pl. **1**: 234. 1818; Roem. & Schult. Syst. **7**: 1565. 1830.

Schoenocaulon gracile Gray in Ann. Lyc. N.Y. **4**: 127. 1837, and in Hook. & Arn. Bot. Beechey's Voy. 388. 1840; Kunth, Enum. Pl. **4**: 185. 1843; Chapman, Fl. South. U.S. 490. 1860; Wats. in Proc. Am. Acad. **14**: 280. 1879; Baker in Jour. Linn. Soc. Bot. **17**: 477. 1879.

Sabadilla dubia Kuntze, Rev. Gen. Pl. **2**: 713. 1891.

Bulb ovoid, small, 1.5–3 cm. in diameter; base of the plant covered for 4–13 cm. with scarious brown scales, separating above into fibers; leaves linear, narrow, suberect, 3–9 dm. long, 1–3 mm. broad;

scape very thin, 3–7 dm. high; spike slender, 10–35 cm. long, 5–8 mm. in diameter, virgate, flowers interruptedly and loosely arranged on the axis, pale green, very small, sessile; perianth-segments oblong, leathery, obscurely or not at all dentate, less than 2.5 mm. long; filaments filiform, very slender, twice the length of the perianth; capsule conic, ovate, nearly sessile, 8–10 mm. long, 5 mm. in diameter, appressed to the axis; seeds 5 mm. or less long, 2–5 in each cell.

Distribution: UNITED STATES.

FLORIDA—ALACHUA CO.: Gainesville, 3 May 1897, *Lighthipe 479* (M, NY, US), March 1876, *Garber* (NY), June 1876, *Garber* (US), open pine land, 15 June 1910, *Hood* (M, 850094), 30 April 1936, and 10 July 1936, *Murrill* (M). BREVARD CO.: Indian River, 1897, *Crawford* (PA); Eau Gallie, dry pine barrens, July 1896, *Curtiss 6551* (G, NY, M, US); Okeechobee Region, scrub-oak land, 10 July 1903, *Fredholm 6032* (G, NY); Mosquito Lagoon, dry pine barrens, June 1879, *Curtiss 2900* (G, M, NY, UC, US). HERNANDO CO.: Brooksville, moist woods, 26 April 1930, *Moldenke 5943* (NY). LAKE CO.: Okahumpka, 3 March 1888, *Burk* (PA); Eustis, June and July 1894, *Hitchcock* (M 210134), June and July 1898, *Hitchcock* (M 210138), *Marsh* (M 760846), high pine land, 1–15 April 1898, *Nash 297* (G, M, NY, UC, US), 16–31 July 1894, *Nash 1447* (PA, US), and 19–30 June 1895, *2016* (NY, US). MARION CO.: east of Flemington, dry sandy woods, 29 April 1930, *Moldenke 1087* (M, NY, US). ORANGE CO.: Lake Brantley, 12 July 1890, *Kline* (PA 517892); Aug. 1894, *Kline* (PA 517891); 7 July 1894, *Lewton* (NY), and 18 July 1894, (PA 517890); Aug. 1894, *ex Herb. Williamson* (PA 509795); Lake Conway, 11 April 1900, *Huger 13* (M); dry pine barren, 12 July 1902, *Fredholm 5387* (G, NY); Lake Helen, pine land, 24 April 1911, *Hood* (M 1073119). OSCEOLA CO.: Lake Gentry, 26 April 1925, *Howell 1105* (US). PASCO CO.: St. Joseph, dry pine lands, 24 April 1927, *O'Neill* (M 953079). POLK CO.: vicinity of Winter Haven, high pine land east of Lake Marion, 12 May 1931, *McFarlin 5261* (CA). VOLUSIA CO.: near Volusia, dry pine ridges, 24 March 1882, *Mohr* (US), dry sandy ridges, 4 April 1882, *Mohr* (US); Seville, dry pine barrens, 7 May 1900, *Curtiss 6606* (G, M, NY, PA, UC, US); De Land, March 1891, *Hulst* (NY), 25 March 1891, *Hulst* [*Hurst*] (UC), 27 March 1891, *Hulst* (NY). FORT KING AND EASTERN FLORIDA: April and May, *Leavenworth* (NY). TAMPA BAY: *Leavenworth* (G); *Alden* (NY); 1834, *Burrows* (NY). LOCALITY INDEFINITE: 1839, Buckley (G, M, NY); *Chapman* (M 210141, US 968641); *Wright* (D 88718, NY).

8. Schoenocaulon Ghiesbreghtii Greenm. in Proc. Am. Acad. **43**: 20. 1907.

Bulb 1–1.5 cm. in diameter; basal portion of the plant covered with brownish-black scales and fibers to a height of 10–12 cm.; leaves narrow, 4–8 dm. long, 2–6 mm. broad; scape straight, 5–6.5 dm. long; spike 1–2.5 dm. long, 1.5–2 cm. in diameter; bract broadly ovate, 2.5 mm. long, obtuse, 5-nerved; flowers sessile or on short pedicels; segments of the perianth oblong, glandular, with two teeth on each margin, 4–4.5 mm. long, 1 mm. broad; filaments more than twice the length of the segments; fruit unknown.

MEXICO—CHIAPAS: *Ghiesbreght 672* (G TYPE, M), and at alt. 2135 m., *Berendt* (G).

9. **Schoenocaulon jaliscense** Greenm. in Proc. Amer. Acad. **43**: 20. 1907.

Bulb oblong-ovoid, 2.5–3.5 cm. in diameter; basal portion of the plant covered with densely massed, tangled, fine, brownish fibers to a height of 14–16 cm.; leaves 6–10 dm. long, 2–7 mm. broad; scape 10–15 dm. long; spike 3–4 dm. long, 12 mm. in diameter; flowers small, shortly pedicelled, irregularly spaced on the axis; perianth-segments linear, with a single tooth on each margin; filaments reddish-purple, twice the length of the perianth; capsule ovate, 6 mm. long, 3 mm. in diameter, on curved pedicel and appressed to the axis.

MEXICO—JALISCO: near Guadalajara, cool grassy sides of canyons, *Pringle 2938* (G TYPE); same locality, steep bluffs of ravines, *Pringle 11853* (G, US).

10. **Schoenocaulon macrocarpum** Brinker, n. sp.[32]

Bulb ovoid, 2.5–3 cm. in diameter; base of the plant covered for 12–14 cm. with coarse black fibers; leaves about 5 dm. long, 2–3 mm. broad; scape 3–4.5 dm. long; spike 10–23 cm. long, about 8 mm. in diameter; flowers small, subsessile, erect, not very closely placed on the axis; perianth-segments ligulate, linear, with a single tooth on each margin; filaments reddish, twice the length of the perianth-segments; capsule linear-oblong, imbricated, appressed to the axis of the inflorescence, 16 mm. long, 4 mm. in diameter; 1–3 seeds in each cell.

MEXICO—NUEVO LEON: Sierra Madre Oriental, Canyon de los Charcos y Mesa de la Camisa, above Alamar, 15 mi. s.w. of Galeana, common in open wood in lower canyon, 4 June 1934, *Mueller 724* (G TYPE, F).

11. **Schoenocaulon megarhiza** Jones, Contr. West. Bot. 14: 29. 1912 (as *megarrhiza*).

Bulb 2.5–3.5 cm. in diameter; basal portion of the plant covered for 10–14 cm. with coarse, brownish-black fibers; leaves 3–7 dm. long, 3–6 mm. wide; scape 4–6 dm. long; spike 2–3 dm. long, 10–12 mm. in diameter; flowers small, sessile to subsessile; perianth-segments 3 mm. long, with a single tooth on each margin; filaments not much longer than the perianth; immature capsule 6 mm. long, 3 mm. in diameter, on a pedicel 3 mm. long; 3–4 seeds in each cell.

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[32] **Schoenocaulon macrocarpum** sp. nov. Bulbus ovoideus, 2.5–3 cm. diametro; caule fibris crassis nigrisque ad 12–14 cm. obtecto; foliis circa 5 dm. longis, 2–3 mm. latis; scapo 3–4.5 dm. longo; spica 10–23 cm. longa, circa 8 mm. diametro; floribus parvis, subsessilibus, erectis, haud arcte dispositis; perianthii segmentis ligulatis, linearibus, utraque margine dente uno; filamentis rubris, perianthii segmentis duplo longioribus; capsulis lineari-oblongis, imbricatis, axi appressis, 16 mm. longis, 4 mm. diametro; seminibus in loculo 1–3.

MEXICO—CHIHUAHUA: Sierra Madre Mts., Guayanopa Canyon, alt. 1525 m., 23 Sept. 1903, *Jones* (P TYPE); transition pine slopes, Sierra Charuco, Rio Fuerte, infrequently scattered along shady banks and under trees, 23 July 1936, *Gentry 2316* (G, M); transition, pine-oak country, solitary in shaded rock outcroppings, Sierra Canelo, Rio Mayo, 30 Aug. 1936, *Gentry 2515* (G, M, UC); San Jose de Pinal, Rio Mayo, transition, pine slopes, in rocky terrain with harsh grass, 5 Sept. 1936, *Gentry 2591* (M). SINALOA: Quebrado de Mansana, Sierra Surotato, open grassy slope, oak forest, alt. 1200–1350 m., 10–14 Sept. 1941, *Gentry 6555* (M).

12. **Schoenocaulon Mortonii** Brinker, n. sp.[33]

Bulb unknown; leaves 6–7 dm. long, 3–5 mm. broad; scape erect, very long, 8.5–10 dm. long; spike many-flowered, 14–23 cm. long, 10–12 mm. in diameter; flowers sessile or on short pedicels, loosely disposed on the axis of the inflorescence; perianth-segments with a single wide tooth on each margin, 3 mm. long; filaments reddish-purple, twice as long as the perianth; capsule unknown.

MEXICO—MICHOACAN: Zitacuaro, Ypasote Hill, alt. 2175 m., steep rocky slope in sparse oak forest, 18 Nov. 1938, *Hinton 13465* (M TYPE, G).

13. **Schoenocaulon obtusum** Brinker, n. sp.[34]

Bulb ovoid, 2–3 cm. in diameter; base of the plant sheathed for 10–20 cm. by a dense cylindrical growth of brown, coarse, rigid fibers; leaves about 5 dm. long, 3–8 mm. broad; scape 25–45 cm. long; spike dense, regular, 8–20 cm. long, 8–10 mm. in diameter; all the flowers maturing simultaneously and of the same disposition on the axis, touching each other, sessile; perianth-segments short, 3 mm. long, obtuse, with a single tooth on each margin; filaments scarcely longer than the perianth; capsules numerous, imbricated and appressed to the axis of the inflorescence, 8–10 mm. long, 5–7 mm. in diameter, 1–3 seeds in each cell.

MEXICO—HIDALGO: Sierra de Pachucha, Sept. 1903, *Rose & Painter 6722* (G, US TYPE); El Chico, "Entre Roca Lumate," July 1929, *Lyonnet 329* (M, NY, US).

14. **Schoenocaulon officinale** (Schlecht. & Cham.) Gray in Hook. & Arn. Bot. Beechey's Voy. 388. 1840; Benth. Pl. Hartw. 29. 1840;

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[33] **Schoenocaulon Mortonii** sp. nov. Bulbus ignotus; foliis 6–7 dm. longis, 3–5 mm. latis; scapo erecto, perlongo, 8.5–10 dm.; spica multiflora, 14–23 cm. longa, anthesi 10–12 mm. diametro; floribus sessilibus vel breviter pedicellatis, laxe dispositis; perianthii segmentis utraque margine dente lato uno, 3 mm. longis; filamentis rubro-purpureis perianthio duplo longioribus; capsulis ignotis.

[34] **Schoenocaulon obtusum** sp. nov. Bulbus ovoideus, 2–3 cm. diametro; caudice cylindro ad 10–20 cm. fibris brunneis crassis rigidis dense obtecto; foliis circa 5 dm. longis, 3–8 mm. latis; scapo 25–45 cm. longo; spica densa, regularis, 8–20 cm. longa, 8–10 mm. diametro; floribus omnibus aequalibus maturitate et dispositione, mutuis tangentibus, sessilibus; perianthii segmentis brevibus, 3 mm. longis, obtusis, utraque margine dente uno; filamentis perianthio haud longioribus; capsulis numerosis, imbricatis et inflorescentiae axi appressis, 8–10 mm. longis, 5–7 mm. diametro; seminibus in loculo 1–3.

loc. cit. 96. 1842; Wats. in Proc. Am. Acad. **14**: 281. 1879; Baker in Jour. Linn. Soc. Bot. **17**: 476. 1879; Hemsl. in Salvin & Godman, Biol. Cent.-Am. Bot. **3**: 383. 1885, in part; Yuncker in Field Mus. Publ. Bot. **17**: 323. 1938.

Veratrum officinale Schlecht. & Cham. in Linnaea **6**: 45. 1831; Nees, Pl. Offic. *pl. 50*. 1821–33.

Helonias officinalis Don in Edinb. N. Phil. Jour. 234. 1832; Lindley, Fl. Med. 586. 1838.

Sabadilla officinarum Brandt (Brandt & Ratzeburg) in Hayne, Arzneig. **13**: *pl. 27*. 1836 [1837]; Schlecht. in Linnaea **18**: 444. 1844; Kuntze, Rev. Gen. Pl. **2**: 713. 1891, as *officinalis;* Standl. & Cald. in List. Prelim. Pl. El Salvador, 49. 1925, as *officinalis;* Knuth in Fedde Rep. Beih. **43**: 199. 1927, in part.

Asagraea officinalis Lindl. in Edwards' Bot. Reg. n.s. **2**: *pl. 33*. 1839; Hook & Arn. Bot. Beechey's Voy. 388. 1840; Kunth, Enum. Pl. **4**: 184, 1843; Spach in Hist. Nat. Veg. Phan. **12**: 245. 1846; Lindl. Med. & Oecon. Bot. 55, *fig. 90*. 1849; Hare, Caspari & Rusby, Nat. Stand. Dispens. 1336, *fig. 354*. 1905.

Asagraea caracasana Ernst in Jour. Bot. **9**: 91. 1871; Hemsl. in Salvin & Godman, Biol. Cent.-Am. Bot. **3**: 383. 1885, in synonomy

Bulb large and thick, 2.5–4 cm. in diameter; base of the plant covered for 8–20 cm. with dark brown scales separating above into fibers; leaves coarse, 3–10 dm. long, 3–15 mm. broad; scape angled below, terete above, 6–12 dm. long, 3–12 mm. in diameter; flowering spike dense, cylindrical, 1–5.5 dm. long, 12–18 mm. in diameter; perianth-segments ligulate, narrowly oblong lanceolate, 3–4 mm. long, margins entire, nectaries prominent at the base of the segment; filament thick, stout, 6–7 mm. long; fruiting spike 2 cm. in diameter; capsules numerous, crowded, elliptic-oblong, 10–13 mm. long, 4–5 mm. in diameter, on pedicels 4 mm. long; bracts deltoid, 3 mm. long; seeds 1–4 in each cell.

Distribution: Mexico, Central America to Venezuela and Peru.

NORTH AMERICA:

MEXICO—CHIAPAS: Fenia, open pine and oak forest, June 1925, ***Purpus 405*** (US); Siltepec, 9 Aug. 1937, ***Matuda 1600*** (F, NY). COLIMA: 9 Jan.–6 Feb. 1891, ***Palmer 1410*** (G, US). MEXICO STATE: Temascaltepec, Telpincla, alt. 1840 m., 17 Nov. 1932, ***Hinton 2480*** (CA); Temascaltepec, Chorrera, alt. 1230 m., 9 Oct. 1932, ***Hinton 2039*** (G, F). MICHOACAN: Zitacuaro, Piedra de Cal, alt. 1300 m., steep rocky slope, 10 Sept. 1938, ***Hinton 13226*** (G, M, NY, US). MORELOS: Hochicalco, on sunny heights, 29 Sept. 1910, ***Seler 5379 (296)*** (G). GUERRERO: Mina, Santa Teresa, grassy hill, oak woods, alt. 1040 m., 12 Sept. 1936, ***Hinton 9397*** (US); Mina, Puerto del Clarin Cayunche, grassy hill, alt. 750 m., 21 Sept. 1936, ***Hinton 9506*** (US); Mina, Calavera, Puerto, oak woods, 19 Sept. 1936, ***Hinton 9539*** (G, NY, US). OAXACA: Santa Efigenia, alt. 150 m., 18 July 1895,

Nelson 2847 (US), and *2849* (F); San Benito, near Apango, alt. 500 m., 11 Oct. 1917, *Reko 3475* (US). VERA CRUZ: Orizaba, June 1857, *Mohr & Botteri* (US), *Botteri 1186* (G, US); Borrego, 1866, *Bourgeau 2981* (G, US), 7 Oct. 1853, *Mueller 222* (G, NY), Uluapam, Oct. 1853, *Mueller 231* (NY), Consoquitla, 1841-43, *Liebmann 14625* (F), Mirador, Oct. 1841, *Liebmann 14627* (F), Aug. 1841, *14628* (G, F, UC, US), and *14629* (F); Maltrata, May 1937, *Matuda 1346* (F, NY); Zacuapan, Fortin, sunny slopes, open woods, Aug. 1906, *Purpus 2023* (F, G, M, NY, UC, US); Cerro de Borego, dry calcareous hills, *collector unknown, 496* (PA). "On the eastern slopes of the Mexican Andes," in the Barranca de Tioselo near the Hacienda de la Laguna, *Schiede & Deppe 982* (M TYPE).

A specimen in the Gray Herbarium labeled "Mexico (Hooker dupl. 1839)" without further data is referable to this species.

CENTRAL AMERICA:

GUATEMALA—DEPT. SANTA ROSA: Rio de Los Esclavos, alt. 750 m., Aug. 1892, *Heyde & Lux (Smith 3874)* (G, NY, US); Alameda, 8 Aug. 1937, *Johnston 961* (F, NY). DEPT. HUEHUETENANGO: Uaxackanal, Quen Santo, open wooded limestone hills, 23 Aug. 1896, *Seler 3220* (G); Chaguial, open wooded limestone hills, 7 Sept. 1896, *Seler 3273* (G, US). DEPT. GUATEMALA: 10 km. s. of San Raimundo, damp wooded barranca, bushy slope, alt. 1800 m., 18 Jan. 1939, *Standley 62922* (F); 1939, *Aguilar 128* (F). DEPT. ZACAPA: lower slopes of Sierra de las Minas, along trail above Rio Hondo, 250–900 m. alt., grassy area, 11 Oct. 1939, *Steyermark 29548* (F). DEPT. CHIQUIMULA: Montana Castilla, vicinity of Montana Cebollas, along Rio Lucia Saso, 3 mi. s.e. of Quezaltepeque, alt. 1200–1500 m., 6 Nov. 1939, *Steyermark 31227* (F). DEPT. JUTIAPA: Lago Retana, between Overo and Progresso, alt. 600 m., 26 Nov. 1939, *Steyermark 32025* (F). WITHOUT DEFINITE LOCALITY: in rocky places, 1840, *Hartweg 627* (NY).

HONDURAS—DEPT. OF COMAYAGUA: 6 km. w. of Siguatepeque, moist soil, river bank, alt. 1250 m., 8 Aug. 1936, *Yuncker, Dawson & Youse 6358* (F, G, M).

EL SALVADOR—Vicinity of San Salvador, *Renson 167* (NY, US); Cerro de San Jacinto, Aug. 1922, *Calderon 1060* (G, M, NY, US).

COSTA RICA—ALAJUELA: San Jose, Nuestro Amo, alt. 800 m., July 1912, *Jimenez 637* (US).

SOUTH AMERICA:

VENEZUELA—CARACAS: Sept. 1929, *Elias 71* (F); grassy hills, *Ernst* (US 601444); 24 June 1917, *Curran & Haman 1196* (CA, F, G, NY, UC, US); mountain sides, alt. 600–1050 m., Dec. 1935, *Lawrance 888* (NY); Middle Catouche wood, in forest, in savannas, alt. 1200–1400 m., 2 Sept. 1917, *Pittier 7352* (G, US); La Guaira, old road, alt. 1100–1300 m., 6 June 1921, *Pittier 9556* (G, US); 31 Oct. 1916, *Rose 21887* (NY, US); Los Chorros, alt. 950 m., Dec. 1939, *Williams 13604* (F); between Caracas and La Guaira, through Brett, *Rose 21887* (US). TOVAR: 1854–5, *Fendler 1506* (G, M). MIRANDA: hills above Los Teques, in open places, 7 Sept. 1924, *Pittier 11611* (NY, US); Los Chorros, alt. 960 m., 20 Nov. 1939, *Williams 12398* (F). LOCALITY UNSPECIFIED: 22 Sept. 1891, *Eggers 13361* (F, US).

PERU—San Miguel, Urubama valley, alt. 1800 m., 31 May 1915, *Cook & Gilbert 1013* (US); Santa Ana, alt. 900 m., 27 June 1915, *Cook & Gilbert 1538* (US). CUZCO: POTRERO, Convencion, alt. 1300 m., 4 March 1940, *Vasgare 1844* (G).

15. Schoenocaulon Pringlei Greenm. in Proc. Am. Acad. **32**: 295. 1897.

Bulb ovoid, 1.5–3 cm. in diameter; base of the plant covered with coarse dark brown fibers to the height of 8–24 cm.; leaves narrow, 2.5–7 dm. long, 1–3 mm. broad; scape straight, 3–7.5 dm. long; flowering spike 2–10 cm. long, 8–10 mm. in diameter; fruiting spike

dense, 15 mm. in diameter; bract rounded at the apex; flowers closely appressed, sessile to subsessile; perianth-segments oblong-ovate, dark-brown, scarious-margined, 4–5 mm. long; filaments scarcely projecting beyond the perianth; capsules imbricated, oblong, 10–12 mm. long, 5 mm. in diameter; seeds small, thin, 4–5 mm. long, 1–5 in each cell.

MEXICO—HIDALGO: between Somoriel and Las Lajas, 5 Aug. 1905, *Rose, Painter & Rose 9843* (G, US). FEDERAL DISTRICT: lava beds, Serrania de Ajusco, alt. 3050 m., 23 Aug. 1896, *Pringle 6451* (CA, G, M, NY, PA, UC, US TYPE); Cima Station, lava fields, alt. 3050 m., 19 Sept. 1903, *Pringle 11716* (G, US), alt. 2981 m., *Pringle 13621* (G, US); La Cima de Ajusco, lava fields, alt. 2981 m., 2 Aug. 1906, *Pringle 13778* (G, US). NAYARIT: near Santa Teresa, top of Sierra Madre, 13 Aug. 1897, *Rose 2227* (US). PUEBLA: Mount Orizaba, 25–26 July 1901, *Rose & Hay 5690* (US).

16. **Schoenocaulon regulare** Brinker, n. sp.[35]

Bulb ovoid, 2–4 cm. in diameter; base of the plant covered for 6–14 cm. by a collar of dark-brown, coarse fibers; leaves shorter than the scape and inflorescence, 2–6 dm. long, 2–5 mm. broad; scape 2.5–6 dm. long; spike loosely flowered, tapering, 10–24 cm. long, 7–10 mm. in diameter; flowers very small, sessile, equal to each other in size and maturity, regularly disposed; perianth-segments very small, with a single tooth on each margin, 2.5 mm. or less long; filaments twice the length of the perianth; capsules subsessile, 8–12 mm. long, 4–5 mm. in diameter; 2–4 seeds in each cell.

MEXICO—JALISCO: Sierra Madre Occidental, trail from San Sebastian to Real Alto, Loma del Oregano, alt. 1500 m., pine forest on steep hill-slope, 18 Feb. 1927, *Mexia 1702* (CA, D, M, NY, UC, US TYPE); w. of San Sebastian, Hacienda del Ototal, Arroyo de los Hormos, alt. 1500 m., near stream, 6 March 1927, *Mexia 1823a* (CA, UC, US); Sierra Madre, w. of Polanos, 15–17 Sept. 1897, *Rose 2987* (G, US). DURANGO: Santiago Papasquiaro, April–Aug. 1896, *Palmer 419* (G, M, NY, UC, US).

17. **Schoenocaulon tenue** Brinker, n. sp.[36]

Bulb small, 1–1.5 cm. in diameter; base of the plant covered for

[35] **Schoenocaulon regulare** sp. nov. Bulbus ovoideus, 2–4 cm. diametro; caudice fibris atro-brunneis crassis ad 6–14 cm. dense obtecto; foliis scapo et inflorescentia brevioribus, 2–6 dm. longis, 2–5 mm. latis; scapo 2.5–6 dm. longo; spica laxiflora, attenuata, 10–24 cm. longa, 7–10 mm. diametro; floribus minimis, sessilibus, magnitudine et maturitate aequalibus, regulariter dispositis; perianthii segmentis minimis, utraque margine dente uno, 2.5 mm. vel minus longis; filamentis perianthio duplo longioribus; capsulis subsessilibus, 8–12 mm. longis, 4–5 mm. diametro; seminibus in loculo 2–4.

[36] **Schoenocaulon tenue** sp. nov. Bulbus parvus, 1–1.5 cm. diametro; caule fibris brunneis filamentosis ad 6–13 cm. alto obtecto; foliis tenuissimis, brevibus, subfiliformibus, 2.5–3.5 dm. longis, .5–2 mm. latis; scapo brevi, erecto, gracili, 16–35 cm. alto; spica 4–10 cm. longa, 10 mm. tantum diametro; floribus paucis, minimis, pedicellatis, distanter dispositis; perianthii segmentis utraque margine dente uno, ligulatis, 2.5–3 mm. longis; filamentis duplo perianthio longioribus; capsulis maturis parvis, 8–10 mm. longis, 4–5 mm. diametro; seminibus in loculo 1–2.

6–13 cm. with brown hair-like fibers; leaves very narrow, short, subfiliform, 2.5–3.5 dm. long, 0.5–2 mm. broad; scape short, erect, slender, 16–35 cm. high; spike 4–10 cm. long, only 10 mm. in diameter; flowers few, very small, pedicelled, distantly disposed on the axis of inflorescence; perianth-segments with a single tooth on each margin, ligulate, 2.5–3 mm. long; filaments twice as long as the perianth; mature capsules small, 8–10 mm. long, 4–5 mm. in diameter, 1–2 seeds in each cell.

MEXICO—MORELOS: cooler grassy slopes of the knobs of the Sierra de Tepoxtlan, alt. 2285 m., Sept.–Nov. 1900, *Pringle 8356* (G, M TYPE, NY, P, PA, UC, US). SAN LUIS POTOSI: Charcas, July–Aug. 1934, *Lundell 5464* (US).

Further collections of this plant may prove its identity with the obscure *S. Coulteri*.

18. **Schoenocaulon tenuifolium** (Mart. & Gal.) Robins. & Greenm. in Am. Jour. Sci. III, **50**: 168. 1895.

Veratrum tenuifolium Mart. & Gal. in Acad. Roy. Brux. Bul. **9**²: 380. 1842; Hemsl. in Salvin & Godman, Biol. Cent.-Am. Bot. **3**: 383. 1885.

Asagraea tenuifolia Kunth, Enum. Pl. **4**: 700. 1843; Hemsley, *l.c.*

Bulb 2.5–4.5 cm. in diameter; base of the plant covered with a sheath of very coarse fibers to the height of 15–30 cm.; leaves 5–9 dm. long, 3–10 mm. broad; scape stout, 10–36 cm. long; flowering spike 7–16 cm. long, 16–20 mm. in diameter at anthesis; subtending bract large, 4 mm. long; fruiting spike fertile at the base only, 4–5 cm. in diameter; flowers large, sessile, densely arranged on the axis; perianth-segments broadly ovate, green tipped with red, margin erose, 5 mm. long, 3 mm. broad; filaments thick, red, twice the length of the perianth; capsule large, inflated, obovate, 18–20 mm. long, 10–12 mm. in diameter; seeds large, oval, 7 mm. long, 5 mm. in diameter, 1–2 in each cell.

MEXICO—OAXACA: Cerro San Felipe, alt. 3000 m., *Conzatti 688* (G); mountains s. of Miahuatlan, alt. 300 m., *Nelson 2530a* (G, US); Sierra de San Felipe, alt. 3011 m., *Pringle 5857* (G, US), alt. 2890 m., *6653* (F, G, NY, M, PA, UC, US), and alt. 3200 m., *10184* (F, G, M, NY, PA, UC, US), alt. 300 m., *Smith 753* (M, US).

19. **Schoenocaulon texanum** Scheele in Linnaea **25**: 262. 1852.

Schoenocaulon Drummondii Torrey in Bot. U.S. & Mex. Bound. Surv. **2**: 222. 1859, as to Pl. Lindh. only; Wats. in Proc. Am. Acad. **14**: 281. 1879, as to synonym; Baker in Jour. Linn. Soc. Bot. **17**: 477. 1879, as to synonym and *Lindheimer 543* and *711;* Wats. in Proc. Am. Acad. **18**: 166. 1883, as to *Coulter 1570* only; Hemsl. in Salvin & Godman, Biol. Cent.-Am. Bot. **3**: 382. 1885; Small, Fl. South-

east. U.S. 250. 1903; Wooton & Standl. in Contr. U.S. Nat. Herb. **19**: 129. 1915, as to synonym.

Schoenocaulon intermedium Baker in Jour. Linn. Soc. Bot. **17**: 477. 1879, as to *Coulter 1568* and *1570*.

Bulb 1.5–2.5 cm. in diameter; basal portion of the plant covered with a dense cylinder of brownish-black fibers 7–15 cm. long; leaves narrow, recurved, 3–6 dm. long, 2–5 mm. broad; scape slender, 3–4.5 dm. long; spike pointed at the apex, densely flowered, 7.5–18 cm. long, 10–15 mm. in diameter; bracts acutish to acute, 2 mm. long; flowers erect, crowded, subsessile, pedicel less than 1 mm. long; perianth-segments linear-oblong, thickened, entire or obscurely dentate, 2 mm. long; filaments slender, slightly dilated toward the base only, 3–4 mm. long; capsules somewhat appressed to the axis of the inflorescence, 10–14 mm. long, 4–7 mm. in diameter; fruiting pedicel 2 mm. long; seeds 5–6 mm. long, 1–3 in each cell; flowering in spring.

Distribution: southwestern United States and northern Mexico.

UNITED STATES:

TEXAS—BEE CO.: Beeville, 30 March 1932, *Jones 29080* (M, P, UC). BEXAR CO.: Leon Springs, tropical life zone, 17 May 1911, *Clemens 483* (CA, M, P); nw. of San Antonio, hard limestone hillside along scenic loop, 26 April 1936, *Metz 2436* (NY); San Antonio, April 1922, *Schulz 792* (US). BREWSTER CO.: 5 mi. n. of Nichols' Ranch House, 4 April 1937, *Warnock T625* (G). COMAL CO.: New Braunfels, stony prairies, dry places, April 1846, *Lindheimer 543* (G, M, NY, PA, UC, US, all ISOTYPES), and April 1848, *711* (G, M, NY, PA); Comanche Spring, 1850, *Lindheimer 1220* (M), and May 1851, *1221* (G, M, NY, PA, UC, US). CULBERSON CO.: ridge above McKittrick Canyon, shaded rocky places, 17 July 1931, *Moore & Steyermark 3485* (CA, D, G, M, NY, PA, UC, US). GILLESPIE CO.: Nibo (?) Mt., *Jermy 329* (M, US). GOLIAD CO.: Goliad, open prairie, March 1927, *Williams 50* (PA). HAYS CO.: San Marcos, rocky uplands, 8 April 1918, *Palmer 13309* (US); San Marcos and vicinity, spring 1898, *Stanfield* (NY). JEFF DAVIS CO.: 17 mi. sw. of Toyahvale, 30 Oct. 1935, *Cory 17533* (G). KENDALL CO.: 8¾ mi. nw. of Boerne, 24 May 1935, *Cory 13988* (G); rocky bluffs, June 1885, *Reverchon 1607* (D, G, M, NY, P, US); Boerne, dry calcareous hills, 22 May 1916, *Palmer 9841* (D, M, PA, US); on limestone hill, e. of Comfort, 29 April 1940, *von Schrenk* (M). KERR CO.: Turtle Creek, 2 May 1899, *Bray 227* (US); about Kerrville, 480–600 m. alt., 12–19 June 1894, *Heller 1626* (G, M, NY, PA, UC, US); Kerrville, sandy loam of stony hill, 9–10 May 1920, *Pennell 10373* (NY, PA). TRAVIS CO.: Bull Creek, 2 May 1926, *Bogusch 546* (US); Austin, 13 May 1872, *Hall 644* (G, M, NY, P, US); near Austin, 24 April 1914, *Young* (M); *Austin*, 18 April 1903, *ex Herb. Biltmore 14799* (US). Between Kerrville, KERR CO. and San Antonio, BEXAR CO.: 23 April 1931, *Jones 78405* (M, P, UC). Between Mason, MASON CO. and Fredericksburg, GILLESPIE CO., 14 May 1932, *McKelvey 2780* (G). WITHOUT DEFINITE LOCALITY: Guadalupe Mts., w. Texas, 1882, *Havard 29* (G, PA); 1881, *Havard* (US). "Between w. Texas and El Paso, New Mexico," May–Oct. 1849, *Wright 697* (G, UC, US). Upper Guadalupe, stony prairie, April 1845, *Lindheimer 416* (G, M); mountainous prairies, May–June 1884, *Reverchon 1607* (M).

NEW MEXICO—CHAVES CO.: 10 mi. w. of Roswell, 28 July 1905, *Wooton* (US). EDDY CO.: Guadalupe Mts., e. of Queen, crevices of rocks, 19 May 1932, *Wilkins 2026* (PA, US).

MEXICO—CHIHUAHUA: Santa Eulalia Mts., May–June 1885, *Pringle 40* (G, NY, PA, US); same locality, 18 Aug. 1887, *Pringle 40* (M 207467), and coll. of 1885, *Wilkinson* (NY). HIDALGO: near Zimapan, *Coulter 1568* and *1570* (G). NUEVO LEON: Monterrey, Sierra Madre Mts., 27 July 1933, *Mueller 12* (G); foothills below Pablillo, 15 mi. sw. of Pueblo Galeana, alt. 2256–2440 m., rare in oak scrub, 21 May 1934, *Mueller 513* (G). PUEBLA: vicinity of Puebla, Hueyotlipan, alt. 2180 m., 15 June 1908, *Arsène 10227* (US); Manzanilla, 20 July 1910, *Nicolas 2302* (US); *Arsène* (US 1031247). TAMAULIPAS: vicinity of Marmolejo, Pico del Diabolo, 12 Aug. 1930, *Bartlett 10918* (US); 10 kilo. n.w. of El Progresso, which is 18 kilo. n.w. of Ocampo, on mountains with luxuriant vegetation, alt. 1450 m., 22 Aug. 1941, *Stanford, Retherford & Northcraft 1055* (M).

20. Schoenocaulon yucatanense Brinker, n. sp.[37]

Bulb unknown; leaves 6 dm. and more long, 6–7 mm. broad; scape slender, 44 cm. long; spike 11 cm. long, 15 mm. in diameter at anthesis; all flowers sessile, erect; bracts small, scarious, very erose; perianth-segments erose-margined, ovate-oblong, about 2.5 mm. long; filaments three times as long as the perianth, slightly dilated above, reflexed, yellow; capsule unknown.

MEXICO—YUCATAN: Uxmal, on base of large pyramid, 20–21 July 1932, *Steere 2093* (NY TYPE).

[37] **Schoenocaulon yucatanense** sp. nov. Bulbus ignotus; foliis 6 dm. et ultra longis, 6–7 mm. latis; scapo gracili, 44 cm. longo; spica 11 cm. longa, anthesi 15 mm. diametro; floribus omnibus sessilibus, erectis; bracteis parvis, scariosis, valde erosis; perianthii segmentis margine erosis, ovato-oblongis, circa 2.5 mm. longis; filamentis perianthio triplo longioribus, superne sensim dilatatis, reflexis, luteis; capsulis ignotis.

Excluded Species

Asagraea frigida (Schlecht. & Cham.) Lyons, Pl. Names Scientif. and Pop., ed. 508. 1907 = **Stenanthium frigidum** Kunth (*Veratrum frigidum* Schlecht. & Cham.), fide Index Kewensis.

Asagraea longiflora Rusby in Bull. N. Y. Bot. Gard. **6**: 491. 1910 = **Tofieldia falcata** Pers. Syn. **1**: 399. 1805.

List of Exsiccatae

The numbers in the parentheses indicate the numbers of the species as treated in the monograph. The collector's numbers are in *italics*; the abbreviation *s.n.* signifies that the specimen is without a collector's number.

Aguilar, I. *128* (14).
Alden, Lieut. *s.n.* (7).
Arsène, Br. G. *s.n.*, *10227* (19).
Bartlett, H. H. *10918* (19).
Berendt, *s.n.* (8).
Biltmore (ex Herb.) *14799* (19).
Bogusch, E. R. *546* (19).
Botteri, M. *1186* (14).
Bourgeau, E. *2981* (14).
Bray, W. L. *227* (19).
Buckley, S. B. *s.n.* (7).
Burk, I. *s.n.* (7).
Burrows, Dr., *s.n.* (7).
Calderon, S. *1060* (14).
Chapman, A. W. (ex Herb.) *s.n.* (7).
Clemens, Mr. and Mrs. J. *483* (19).

Conzatti, C. *688* (18).
Conzatti, C. & Gonzales, V. *323* (3); *449* (4).
Cook, O. F. & Gilbert, G. B. *1013, 1538* (14).
Cory, V. L. *16146, 20644* (6); *13988, 17533* (19).
Coulter, T. *1569* (5); *1568, 1570* (19).
Crawford, J. *s.n.* (7).
Curran, H. M. & Haman, M. *1196* (14).
Curtiss, A. H. *2900, 6551, 6606* (7).
Drummond, T. *284* (6).
Eggers, H. F. A. von. *13361* (14).
Ehrenberg, K. *s.n.* (2).
Elias, Br. *71* (14).
Ernst, A. *s.n.* (14).
Fendler, A. *1506* (14).
Fredholm, A. *5387, 6032* (7).
Garber, A. P. *s.n.* (7).
Gentry, H. S. *2315, 2515, 2591, 6555* (11).
Ghiesbreght, A. *672* (8).
Gregg, J. *214* (2).
Groth, B. H. A. *202* (6).
Hall, E. *644* (19).
Hartweg, T. *627* (14).
Havard, V. *s.n., 29* (19).
Heller, A. A. *1629* (19).
Hinton, G. B. *2690, 4970* (4); *13465* (12); *2039, 2420, 9397, 9506, 9539, 13226* (14).
Hitchcock, A. S. *s.n.* (7).
Hood, S. C. *s.n.* (7).
Howell, A. H. *1105* (7).
Huger, A. M. *13* (7).
Hulst, G. P. *s.n.* (7).
Jermy, G. *329* (19).
Jimenez, O. *637* (14).
Jones, M. E. *s.n.* (11); *29080, 78405* (19).
Johnston, T. R. *961* (14).
Kline, *s.n.* (7).
Lawrance, A. E. *888* (14).
Leavenworth, M. C. *s.n.* (7).
Lewton, F. L. *s.n.* (7).
Liebmann, F. M. *14625, 14627, 14628, 14629* (14).
Lighthipe, L. H. *479* (7).
Lindheimer, F. *416, 543, 711, 1220, 1221* (19).
Lundell, C. L. *5464* (17).
Lyonnet, C. E. *329* (13).
Manry, P. *6257* (6).
Marsh, E. G. *s.n.* (7).
Matuda, E. *1346, 1600* (14).
McFarlin, J. B. *5261* (7).
McKelvey, S. D. *2780* (19).
Metz, M. C. *2436* (19).
Mexia, Y. *1702, 1823a* (16).
Mohr, C. A. *s.n.* (7).
Mohr, C. A. & Botteri, M. *s.n.* (14).
Moldenke, H. N. *1087, 5943* (7).
Moore, J. A. & Steyermark, J. A. *3485* (19).
Mueller, C. H. & M. T. *724* (10); *12, 513* (19).
Mueller, F. *222, 231* (14).
Murrill, W. A. *s.n.* (7).
Nash, G. V. *297, 1447, 2016* (7).
Nelson, E. W. *2847, 2849* (14); *2530a* (18).
Nicolas, F. *5302* (19).
O'Neill, H. *s.n.* (7).
Palmer, E. *119, 1322* (6); *1410* (14); *419* (16).
Palmer, E. J. *9841, 13309* (19).
Parks, H. B., *s.n.* (6).
Parry, C. C., Bigelow, J. M., Wright, C. & Schott, A. *1482* (6).
Parry, C. C. & Palmer, E. *882* (3).
Pennell, F. W. *5557* (6); *10373* (19).
Pittier, H. *7352, 9556, 11611* (14).
Pringle, C. G. *5754, 6740* (1); *13841* (4); *2938* (9); *6415, 11716, 13621, 13778* (15); *8356,* (17); *5857, 6653, 10184* (18); *40* (19).
Purpus, C. A. *4387* (2); *2731* (3); *2490* (4); *405, 2023* (14).
Reko, B. P. *3475* (14).
Renson, C. *167* (14).
Reverchon, J. *1607* (19).
Riddell, J. *s.n., 52* (6).
Rose, J. N. *2227* (15); *2987* (16).
Rose, J. N. & J. S. *21887* (14).
Rose, J. N. & Hay, R. *5690* (15).
Rose, J. N. & Hough, W. *4972* (2).
Rose, J. N. & Painter, J. H. *6722* (13).
Rose, J. N., Painter, J. H. & Rose, J. S. *9243* (15).
Rose, J. N. & Russell, P. G. *24160* (6).
Schaffner, J. G. *228, 536* (3).
Schiede, C. J. W. & Deppe, F. *982* (14).
Schlottmann, *s.n.* (6).
Schott, A. *s.n.* (6).
Schrenk, H. von. *s.n.* (19).
Schulz, E. D. *792* (19).
Seler, C. & E. *3220, 3273, 5379* (14).
Smith, C. L. *753* (18).
Smith, J. D. *3874* (14).
Standley, P. C. *62922* (14).

Stanfield, S. W. *s.n.* (19).
Stanford, L. R., Retherford, K. L. & Northcraft, R. D. *1055* (19).
Steere, W. C. *2093* (20).
Steyermark, J. A. *29548, 31227, 32025* (14).
Vasgare, C. *1844* (14).
Warnock, B. H. *T625* (19).
Whiting, A. F. *523* (3).
Wilkins, H. *2026* (19).
Wilkinson, E. *s.n.* (19).
Williams, C. B. *50* (19); *91* (6).
Williams, L. *12398, 13604* (14).
Wooton, E. O. *s.n.* (19).
Wright, C. *697* (19).
Wright, S. H. *s.n.* (7).
Young, M. S. *s.n.* (19).
Yuncker, T. G., Dawson, R. F. & Youse, H. R. *6385* (14).

Index to Genera and Species

Accepted names are printed in Roman type; synonyms in *italics;* new names and new combinations, in **bold face** type.

EXPLANATION OF PLATE

PLATE 27

Center: Generalized flower of *Schoenocaulon*, × 4½.

Figs: A-G: Capsules.

Fig. A. ***S. tenue***, × 4.

Fig. B. ***S. calcicola***, × 5½, ***S. regulare***, × 5½, ***S. officinale***, × 5, ***S. texanum***, × 5.

Fig. C. ***S. Pringeli***, × 5.

Fig. D. ***S. macrocarpum***, × 4½.

Fig. E. ***S. tenuifolium***, × 4½.

Fig. F. ***S. Conzattii***, × 4, ***S. dubium***, × 4, ***S. jaliscense***, × 6, ***S. megarhiza***, × 6, ***S. obtusum***, × 4.

Fig. G. ***S. caricifolium***, × 4½, ***S. comatum***, × 6.

Figs. 1-13: Perianth-segments.

Fig. 1. ***S. regulare***, × 3.

Fig. 2. ***S. Drummondii***, × 4.

Fig. 3. ***S. officinale***, × 4.

Fig. 4. ***S. yucatanense***, × 4½.

Fig. 5. ***S. Pringlei***, × 4.

Fig. 6. ***S. obtusum***, × 4, ***S. tenue***, × 5.

Fig. 7. ***S. Mortonii***, × 4½.

Fig. 8. ***S. dubium***, × 4.

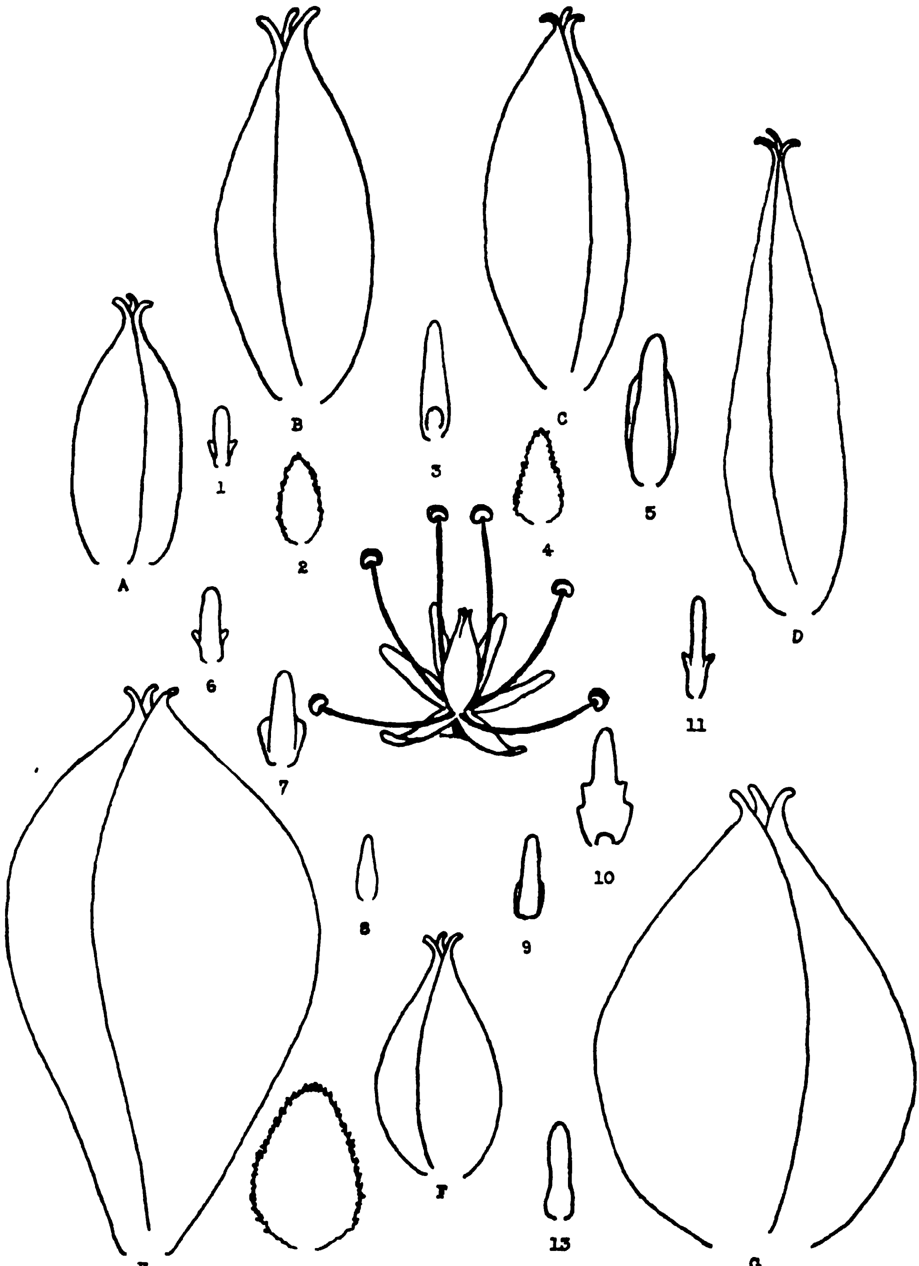
Fig. 9. ***S. caricifolium***, × 4.

Fig. 10. ***S. Ghiesbreghtii***, × 4.

Fig. 11. ***S. macrocarpum***, × 5; ***S. texanum***, × 4; ***S. jaliscense***, × 5; ***S. calcicola***, × 4; ***S. Conzattii***, × 3; ***S. megarhiza***, × 6; ***S. Coulteri***, × 4.

Fig. 12. ***S. tenuifolium***, × 4.

Fig. 13. ***S. comatum***, × 4.

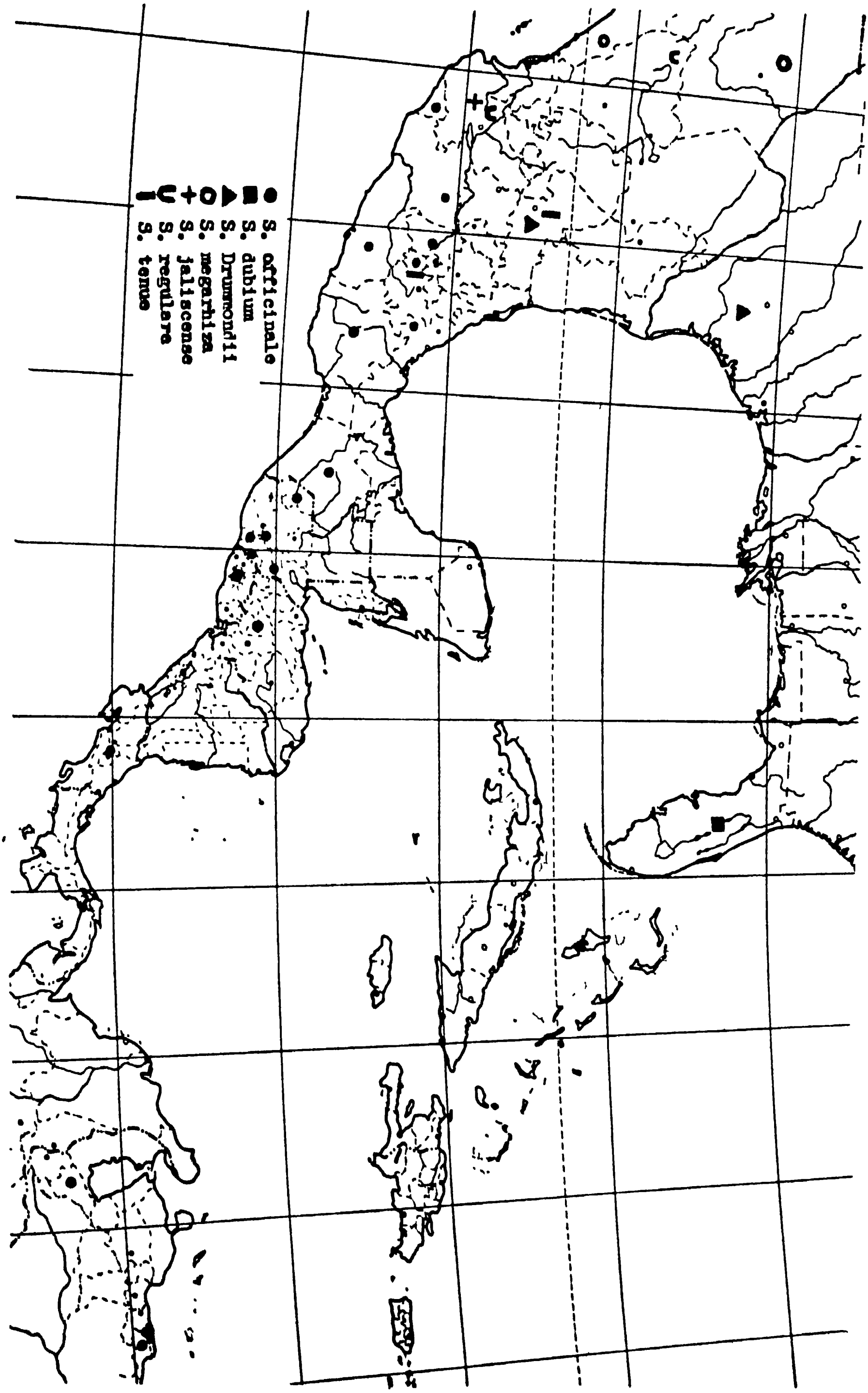


BRINKER—MONOGRAPH OF SCHOENOCAULON

Explanation of Plate

PLATE 28

Map showing geographical distribution of species of *Schoenocaulon*.

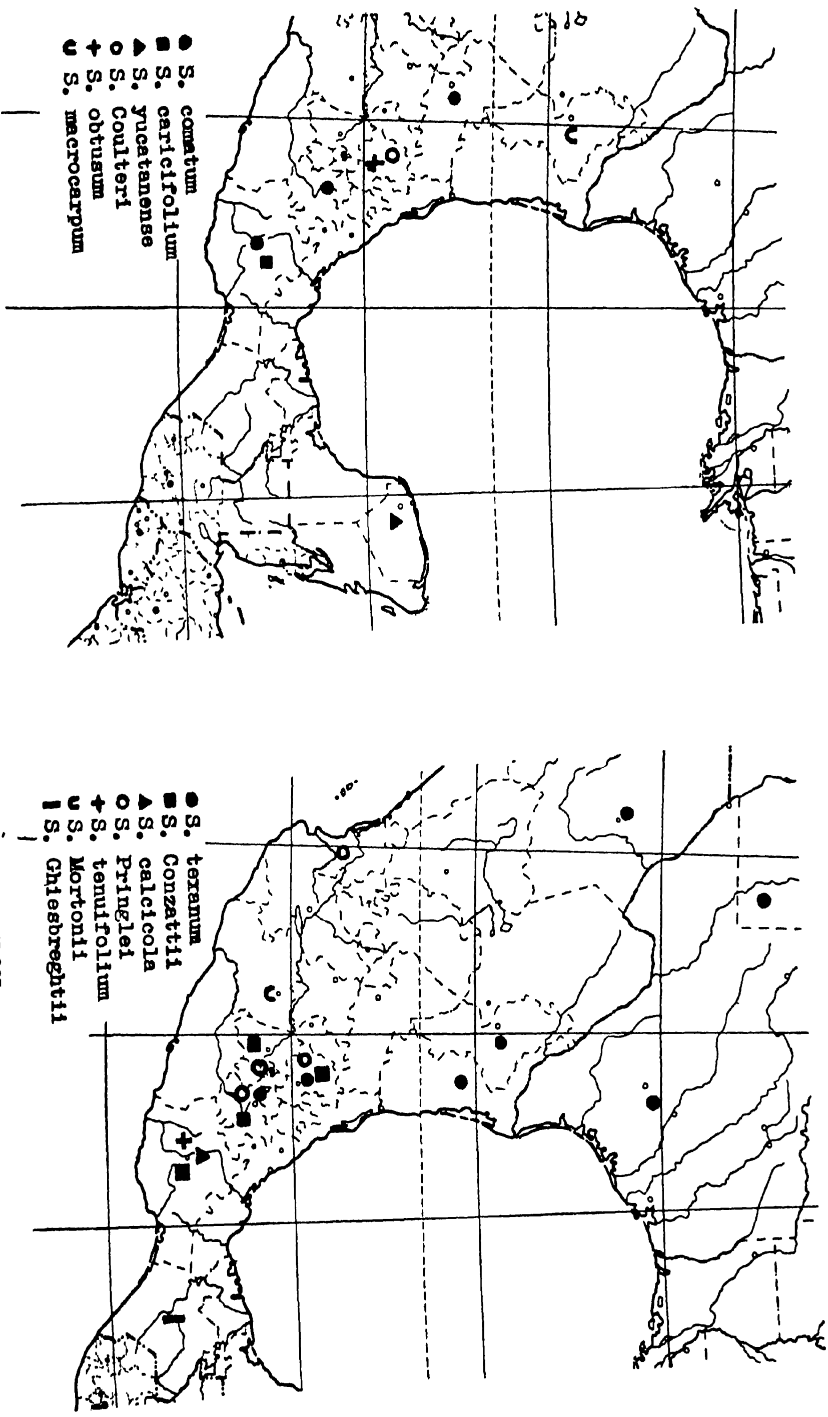


BRINKER—MONOGRAPH OF SCHOENOCAULON

Explanation of Plate

PLATE 29

Maps showing geographical distribution of species of *Schoenocaulon*.



BRINKER—MONOGRAPH OF SCHOENOCAULON

CONTRIBUTIONS TOWARD A FLORA OF PANAMA[1]

VI. COLLECTIONS CHIEFLY BY H. VON WEDEL IN BOCAS DEL TORO

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GRAMINEAE

(Jason R. Swallen)

Cryptochloa Swallen, gen. nov.

Monoecia; spiculis masculis et femineis in eadem inflorescentia dispositis; spiculae masculae: glumae et lemma sterile nulla; lemma acutum vel acuminatum, 1-nervio; palea lemma aequans; stamina 3; spiculae femineae: gluma prima nulla; gluma secunda et lemma sterile subaequalia acuta vel acuminata, 3–5-nervia, nervis lateralibus approximatis; fructus stipitatus, subcylindricus, firmus, albus vel fuscus, marginibus non involutis; palea lemma aequans. Perennis culmis gracilibus, planis, et laminis latis, planis, breve petiolatis.

Low monoecious perennial grasses with broad flat blades usually crowded toward top of the slender wiry culms. Inflorescence small, usually partly hidden in the upper sheaths, each bearing both staminate and pistillate spikelets in no definite arrangement; staminate spikelet: glumes and sterile lemma wanting; lemma and palea acute or acuminate, thin, the lemma 1-nerved; stamens 3; pistillate spikelet: first glume wanting; second glume and sterile lemma acuminate, subequal, 3- or usually 5-nerved, the lateral nerves approximate, finely transversely veined; fertile floret subcylindrical, raised on the enlarged and thickened segment of the rachilla; lemma firm, subindurate, smooth and shining, gradually narrowed to the blunt tip, the margins not inrolled; palea as long as the lemma, similar in texture.

A genus of southern Mexico and Central America.

Type species: *C. variana.*

Name from κρυπτὸς, hidden, χλόα, grass, referring to the partly enclosed panicles and also its forest habitat.

[1] Issued December 18, 1942.

This genus is closely related to *Raddia* Bertol. (*Strephium* Schrad., type *S. distichophyllum*) and has been confused with it. *Raddia*, however, has the staminate and pistillate spikelets in separate inflorescences (the staminate terminal or from the upper nodes, the pistillate axillary); the fertile floret is not raised on the lengthened and thickened segment of the rachilla; the fruit is much smaller, oval or ovate rather than subcylindrical, and the lateral nerves of the second glume and sterile lemma are evenly spaced rather than approximate.

Diandrolyra Stapf and *Olyra* L. are also close kin. The first is distinguished by the spikelets arranged in pairs, one staminate and one pistillate, the fruit is not raised on an enlarged segment of the rachilla, and the lateral nerves of the second glume and sterile lemma are evenly spaced rather than approximate. There are also only two rather than three anthers. In *Olyra* the panicles are all terminal on the main culm and branches, not axillary, the pistillate spikelets at the ends of the branches and the staminate below. The second glume and sterile lemma are usually attenuate, with the lateral nerves evenly spaced, not approximate. The fruit is sessile, relatively broad and thick, with the margins of the lemma inrolled, rather firmly clasping the palea.

KEY TO SPECIES

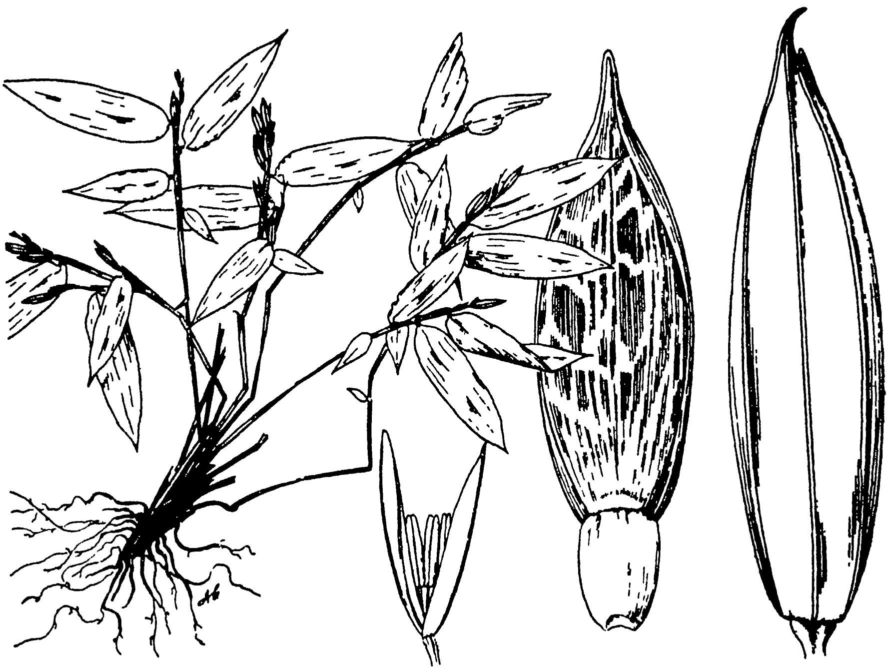
Culms 10–30 cm. high, slender; staminate spikelets 2.5–3 mm. long.
- Blades 3–5 at the summit of each culm, 3–5 cm. long, not conspicuously distichous .... 1. *C. variana*
- Blades 10–20 at the summit of each culm, 1.5–3 cm. long, conspicuously distichous .... 2. *C. concinna*

Culms 20–50 cm. high, at least some of them more than 30 cm., relatively coarse; staminate spikelets 4.5–5 mm. long.
- Panicles, or at least some of them, exserted on long slender peduncles; blades oblong, 3.5–5.5 cm. long, mostly 12–20 mm. wide; second glume and sterile lemma of pistillate spikelets smooth; lemma of staminate spikelets acute..3. *C. strictiflora*
- Panicles, all of them, partly enclosed in the sheaths, the peduncles short; blades lanceolate, 6–7.5 cm. long, 10–13 mm. wide (occasionally as much as 10 cm. long and 27 mm. wide); second glume and sterile lemma of fertile spikelet granular-roughened; lemma of staminate spikelet subattenuate............4. *C. granulifera*

1. CRYPTOCHLOA **variana** Swallen, sp. nov. Culmi caespitosi, 10–20 cm. alti, infra nodos pubescentes; vaginae carinatae marginibus pubescentibus; ligula 1–3 mm. longa, obtusa, pubescens; laminae 3–5 cm. longae, 8–13 mm. latae, oblongo-lanceolatae, acutae vel acuminatae, minute pubescentes; spiculae masculae 2.5 mm. longae, lemmate subacuto; antherae 1 mm. longae; spiculae femineae 7–8.5

mm. longae, gluma secunda et lemmate sterili acutis vel acuminatis, 3-nerviis, glabris; fructus 6.5–7 mm. longus, subcylindricus, fuscus.

Culms in small dense tufts, wiry, 10–20 cm. tall, erect to spreading, often geniculate at the densely pubescent nodes, glabrous, or pubescent below the nodes, the lower internodes somewhat elongate, the upper ones much shorter, completely hidden by the overlapping sheaths; sheaths keeled, pubescent toward the summit and on the margins, nearly glabrous on the back, often auriculate, the auricle



Cryptochloa variana: Plant, × ½; staminate spikelet, fruit, and pistillate spikelet, × 10.

fused with the ligule, the lower ones bladeless or with very much reduced blades; ligule 1–3 mm. long, membranaceous, obtuse, puberulent on the back or nearly glabrous; blades 3–5 on each culm, crowded toward the summit, 3–5 cm. long, 8–13 mm. wide, oblong-lanceolate, rather abruptly narrowed to an acute or acuminate tip, broad and rounded at the base, with a densely pubescent petiole about 1 mm. long, minutely pubescent on both surfaces or sometimes only obscurely puberulent; inflorescences terminal and axillary, partly enclosed in the sheaths, 2–3 cm. long, bearing 1–6 pistillate spikelets, the branches closely appressed, usually pubescent; staminate spikelet 2.5 mm. long, the lemma subacute, the palea as

long as or slightly longer than the lemma; anthers 1 mm. long; pistillate spikelet 7–8.5 mm. long, the pedicel 4–10 mm. long, relatively stout, much enlarged toward the summit; second glume and sterile lemma 3-nerved, with a few fine transverse nerves, glabrous or obscurely scaberulous, the second glume acute, the sterile lemma acute or subacuminate, slightly exceeding the second glume; fruit 6.5–7 mm. long, 2 mm. broad, subcylindrical, broadest above the middle, gradually narrowed to a blunt tip, smooth, shining, gray-greenish, at maturity mottled with darker drab; rachilla segment between the sterile lemma and the fruit enlarged and elongated, 1–1.5 mm. long, about as thick as the base of the fertile floret, whitish, somewhat soft or waxy in appearance; caryopsis 4.5 mm. long, light brown.

PANAMA: CANAL ZONE: near bank of Madden Reservoir, *Muenscher 12212.* COCLÉ: hills north of El Valle de Antón, alt. 1000 m., July 14, 1940, *Allen 2201* (U. S. National Herb., TYPE).

The name *variana,* meaning vari-colored, refers to the mottled fruits.

2. CRYPTOCHLOA **concinna** (Hook f.) Swallen, comb. nov. *(Olyra concinna* Hook. f. Bot. Mag. [Curtis] III, **52**: *pl. 7469.* 1896; *Raddia concinna* Chase, Proc. Biol. Soc. Washington **21**: 185. 1908.). Culms 15–30 cm. high, slender, erect, or geniculate at the lower nodes, the lower and especially the middle internodes much elongated, the upper ones very short; sheaths keeled, glabrous or pubescent; ligule truncate, 0.3–1 mm. long; blades 1.5–3 cm. long (usually 2 cm.), 5–9 mm. wide, crowded on the upper third of the culm, 10–20 on each culm, conspicuously distichous; inflorescences small, almost entirely hidden in the uppermost sheaths; fertile spikelet 8–10 mm. long, the second glume and sterile lemma subequal, subacuminate, 3–5-nerved, with fine transverse veins, glabrous; fruit about 8 mm. long, subcylindrical, scarcely broadened above the base, gradually narrowed to the blunt or rounded tip.

Wet forests at low altitudes, Nicaragua, Costa Rica, and Colombia.

NICARAGUA: Sandy Bay, 1922, *Hamilton s.n.*

COSTA RICA: LIMÓN: Hamburg Finca, Río Reventazón below Cairo, *Standley 48661, 48783, 48854; Oesterr. Biol. Costarica-Expedition 680,* 1930, (coll. *Cufodontis).*

COLOMBIA: BOLÍVAR: Norosi-Tiquisio trail, Lands of Loba, *Curran 129.*

3. Cryptochloa **strictiflora** (Fourn.) Swallen, comb. nov. (*Strephium strictiflorum* Fourn. Bull. Soc. Bot. Belg. **15**: 465. 1876; *Olyra strictiflora* Hemsl. Biol. Cent. Am. Bot. **3**: 510. 1885; *Raddia strictiflora* Chase, Proc. Biol. Soc. Washington **21**: 185. 1908.). Culms 20–50 cm. high, erect or geniculate at the lower nodes, pubescent, more so on one side than the other, the nodes retrorsely pubescent, the intermediate internodes elongate; sheaths keeled, glabrous or pubescent; ligule 2–3 mm. long, obtuse, fused with the auriculate summit of the sheath; blades scarcely crowded, sometimes not at all, oblong, 3.5–5.5 cm. long, 12–20 mm. wide, abruptly narrowed to an acute tip, glabrous or minutely puberulent, the margins scabrous; inflorescences terminal and axillary from the middle and upper sheaths, at least some of them on long slender exserted peduncles; staminate spikelets 4.5 mm. long, the lemma acute; fertile spikelet 11–12 mm. long, the second glume and sterile lemma acuminate, subequal, 5-nerved, very faintly transversely veined; fruit 7 mm. long, subcylindrical with nearly parallel margins, ivory-white.

Gulf region of Mexico.

Mexico: veracruz: Mirador, *Liebmann 266;* Hacienda de Jovo, *Liebmann 267;* Córdoba, 1865-66, *Bourgeau.*

4. Cryptochloa **granulifera** Swallen, sp. nov. Culmi graciles, erecti, ad 50 cm. alti, nodiis pubescentibus; vaginae carinatae glabrae vel ad apicem pubescentes; ligula 0.5–2 mm. longa, obtusa; laminae lanceolatae, 6–7.5 cm. longae, 10–13 mm. latae, acuminatae, marginibus scabris; paniculae 2–5 cm. longae, contractae; spiculae masculae 4.5–5 mm. longae, lemmate subattenuato; spiculae femineae 11–12 mm. longae, gluma secunda et lemmate sterili acuminatis, 5-nerviis, granulosis; fructus 7–8 mm. longus, albus.

Culms slender, erect, occasionally somewhat geniculate at the lower nodes, as much as 50 cm. high, pubescent in a line on one side, the nodes retrorsely pubescent, otherwise glabrous; sheaths keeled, glabrous, or pubescent toward the summit, mottled with dark spots; ligule 0.5–2 mm. long, obtuse, pubescent, fused with the auriculate summit of the sheath; blades broadly lanceolate, the upper ones 6–7.5 cm. long, 10–13 mm. wide (sometimes 20 mm.), rather gradually narrowed to an acuminate tip, glabrous on both surfaces, the margins scabrous; panicles 2–5 cm. long, contracted, partly enclosed in the upper sheaths; staminate spikelets 4.5–5 mm. long, the lemma acuminate or subattenuate, appearing as if awned; fertile spikelet 11–12 mm. long, the second glume and sterile lemma subequal, acu-

minate, 5-nerved, finely transversely nerved, granular-roughened; fruit 7–8 mm. long, ivory-white, narrowed at the summit to a blunt tip.

Forests, Mexico, Honduras and Guatemala.

MEXICO: VERACRUZ: Fortuña, Coatzacoalcos River, *Williams 8378.* CHIAPAS: Finca Irlanda, *Purpus 7403.*

HONDURAS: Puerto Siena, forest along Tela River, Feb. 4, 1903, *Wilson 325* (U. S. National Herb., TYPE).

GUATEMALA: SAN MARCOS: Río Mopá, below Rodeo, *Standley 68769.* This specimen differs from the type in having blades as much as 10 cm. long and 27 mm. wide.

CYCLANTHACEAE

CARLUDOVICA DRUDEI Mast.—CHIRIQUÍ: vicinity of Puerto Armuelles, alt. 0-75 m., July 28-31, 1940, *Woodson & Schery 910.* Originally described from plants of Colombian origin cultivated at Kew.

CARLUDOVICA ENSIFORMIS Hook.f.—CHIRIQUÍ: vicinity of Bajo Chorro, alt. 1900 m., July 20-22, 1940, *Woodson & Schery 625*; Casita Alta to Cerro Copete, Volcán de Chiriquí, alt. 2300-3300 m., July 10, 1940, *Woodson & Schery 373.* Previously considered to be an endemic of Costa Rica.

CARLUDOVICA **integrifolia** Woodson, sp. nov. Planta ut videtur gracilis scandens. Folia longiuscule petiolata membranacea; lamina 22–30 cm. longa 4–6 cm. lata elliptico-oblanceolata apicem versus late acuta ibique levissime crenulata deinde abrupte angusteque subcaudato-acuminata basim versus (ca. 2/3 longitudine) integra gradatim acuta; petiolo 12–15 cm. longo ca. 2/3 longitudine vaginato. Pedunculus 5–6 cm. longus tenuis, spatharum nodiis ca. 3 sat distantibus. Spadix in fructu immaturo fusiformi-cylindricus ca. 2.0—2.5 cm. longus basi ca. 0.4 cm. crassus; floribus femineis parvis concrescentibus ca. 0.5 cm. diam., stigmatibus sessilibus parvis, lobis perigonialibus tenuissimis vix manifestis. Spathae deciduae ut videntur ca. 3 parvae pedunculi in parte dimidia superiore gestae.—DARIÉN: along the Sambú River, southern Darién, above tide limit, Feb., 1912, *Pittier 5560* (U. S. Nat. Herb., TYPE).

As far as I am aware, only three species of *Carludovica* previously have been described with entire leaves: *C. diversa* Drude, *C. Trailiana* Drude, and *C. heterophylla* Mart., all from Brazil. The three species previously described apparently were found with both entire and bifid leaves (the entire leaves all of outline significantly different from ours), with larger spadices, and with only 1 or 2 spathes.

Our type specimen bears 6 leaves, all entire and so uniform as to indicate that to be the normal condition of the foliage.

Another entire-leaved *Carludovica* was collected by P. C. Standley in the garden of C. W. Powell at Balboa, C. Z., in 1925. The specimen (in U. S. Nat. Herb. no. 1252076) consists of a single leaf of the same general outline as those of *C. integrifolia* but much larger (about 50 cm. long, 12 cm. broad), and is accompanied by the following remarks: "Said to be from the nearby woods. Acaulescent. Leaves all simple." No similar plants have been encountered in the Canal Zone since that time, and the cultivated plant apparently was lost when Mr. Powell's collections were removed by the Missouri Botanical Garden.

Carludovica Killipii Standl.—darién: Cerro de Garagará, Sambú basin, southern Darién, alt. 500–974 m., Feb. 7, 1912, *Pittier 5658*. Originally described (Field Mus. Publ. Bot. **22**: 65. 1940) from the region of Buenaventura Bay, Colombia. I have not been able to check the Pittier specimen with that of Killip, but Schery, who has seen both, regards them as probably conspecific.

Carludovica microcephala Hook.f.—bocas del toro: Water Valley, Sept. 23, 1940, *H. von Wedel 921*. Previously known to occur in the Greater Antilles, Honduras, and Costa Rica.

Carludovica microphylla Oerst.—chiriquí: Río Chiriquí Viejo valley, April 8, 1938, *G. White 75;* vicinity of Bajo Mona and Quebrada Chiquero, alt. 1500 m., July 18, 1940, *Woodson & Schery 567*. Previously considered as an endemic of Costa Rica. *White 75* is quite typical of the species as exemplified by other herbarium specimens. However, *Woodson & Schery 567* has very slender leaves attaining 60 cm. in length and seems to correspond perfectly with the diagnosis of *C. stenophylla* Standl. (Fl. Costa Rica, p. 130. 1937) which was described from sterile plants. Our flowering and fruiting specimens have inflorescences quite conformable with those of *C. microphylla,* particularly with regard to the persistent spathes. Since similarly sharp leaf variation has been found to occur in other species represented by a number of herbarium specimens (cf. *C. ensiformis* and *C. Oerstedii*), we are tentatively regarding *C. stenophylla* as a synonym of *C. microphylla*.

Carludovica **Pittieri** Woodson, sp. nov. Planta mediocris ut videtur subacaulis. Folia longe-petiolata membranacea; lamina ca. 28 cm. longa medio ca. 15 cm. lata apicem versus ca. 1/4 longitudine bifida, segmentis late ovato-trigonalibus late acutis; petiolo 19 cm. longo evaginato. Pedunculus 5 cm. longus prope medium 2 nodiis

bractealibus (bracteis deciduis). Spadix in fructu globosus ca. 2.0–2.5 cm. diam.; floribus femineis sat magnis concrescentibus ca. 0.8 cm. diam., stigmatibus sessilibus, lobis perigonialibus depressis stigmata vix aequantibus.—SAN BLAS: high hills back of Puerto Obaldía, alt. 50–200 m., Aug., 1911, *Pittier 4312* (U. S. Nat. Herb., TYPE).

This species is conspicuous amongst the Central American Carludovicas because of its broad, scarcely divided leaves, recalling those of *C. latifrons* Drude of Brazil. The latter, however, has more deeply divided leaves of a different shape, and the stigmas are supported by rather slender styles.

CARLUDOVICA ROTUNDIFOLIA Wendl.—CHIRIQUÍ: Quebrada Velo, Volcán de Chiriquí, alt. 1800 m., July 8, 1940, *Woodson & Schery 248*; vicinity of Bajo Chorro, alt. 1900 m., July 20-22, 1940, *Woodson & Schery 675*. Originally described from Costa Rican plants grown at Kew. *C. rotundifolia* has usually been regarded as a synonym of the widespread *C. palmata* R. & P., but it probably should be maintained from the latter on the basis of the more elongate fruiting perigonial lobes and foliaceous outer spathes of the inflorescence.

COMMELINACEAE

COCHLIOSTEMA ODORATISSIMUM Lem.—BOCAS DEL TORO: Isla Lobo, Chiriquí Lagoon, Sept. 6, 1941, *H. von Wedel 2627*. "Wercklé has published the following statement: 'In the mountains south of Turruvares a gigantic *Cochliostema* is abundant, and covers the thick trunks of trees. It is a very beautiful epiphyte.' He reports it also from the Cordillera de Dota, as a plant 2 meters in height. The genus is known only from Ecuador, but probably it is represented also in Costa Rica." [Standl. Fl. Costa Rica, p. 163. 1937]. This is one of the most interesting discoveries in Panama during recent years, and it comes as a distinct surprise, also, to find it growing so near sea-level, instead of in the mountains where it might have been expected. Although the species is so infrequently collected that I have not been able to compare our plant with other herbarium specimens from South America, the determination appears to be established by reference to the numerous published icones. Of *C. odoratissimum,* Sir J. D. Hooker wrote: "This superb plant certainly ranks amongst the grandest stemless Monocotyledons known, combining the foliage of a gigantic *Anthurium* with masses of inflorescence which, for size, delicacy, and beauty of tints, cannot well be surpassed." [Bot. Mag. *pl. 5705.* 1868.]

LILIACEAE

ECHEANDIA **prolixa** Woodson, sp. nov. Herbae perennes 6–10 dm. altae omnino glabrae; rhizoma brevi recta; radicibus multis carnosis tuberos elongato-fusiformes gerentibus. Folia plurima radicalia late linearia 60–95 cm. longa ca. 2 cm. lata, caulina 1–2 minora. Inflorescentia prolixa plus minusve procumbens paniculato-racemiformis; ramis 3–6 saepissime 2–4 ex axilla unica; bracteis scariaceis minimis. Flores parvi in fasciculis aggregati; pedicellis 1.0–1.5 cm. longis sub medio articulatis; perianthii segmentis anguste oblongo-linearibus 1.0–1.2 cm. longis ca. 0.1 cm. latis albis patulis; staminis antheris oblongo-sagittatis 0.6 cm. longis, filamentis rugosis aequilongis. Capsulae trigone obovoideo-oblongoideae apice truncatae vel leviter emarginatae basi attenuatae 0.7–0.8 cm. longae ca. 0.4 cm. latae.—PANAMÁ: vicinity of Bejuco, alt. about 20 m., Sept. 7, 1942, *P. H. Allen 2962* (Herb. Missouri Bot. Gard., TYPE). "Common weedy herb growing in lax clumps on rocky hilltops. Inflorescence weakly procumbent in most cases. Flowers white with yellow stamens."

This species is conspicuous amongst described Echeandias because of its rank growth. It is most nearly allied to *E. macrophylla* Rose, but material of that species which is available for study shows plants which are smaller in general stature, with anthers about 1 cm. long and filaments about 0.6 cm. long, as well as broader almost exactly ovoid capsules. The genus *Echeandia* has previously been known only from southern Mexico and northern Central America, with the exception of a single specimen (*Fendler 1549*) from northwestern Venezuela which possibly represents *E. prolixa.* An additional *Echeandia* is known from western Panama:

ECHEANDIA **venusta** Woodson, sp. nov. Herbae perennes ca. 3–4 dm. altae omnino glabrae; rhizoma brevi recta; radicibus multis carnosis. Folia plurima radicalia late linearia 12-30 cm. longa 1.0–1.5 cm. lata multinervia albomarginata, caulina 1–2 multo minora. Inflorescentia racemiformis saepissime simplex; floribus in fasciculis aggregatis vel solitariis; bracteis exterioribus valde foliaceis spathaceis 2–7 cm. longis; pedicellis 1.5–2.0 cm. longis sub medio articulatis; perianthii segmentis aureis nervis 3 nigris oblongo-ellipticis 1.5–2.0 cm. longis 0.4–0.5 cm. latis; staminis antheris anguste oblongo-sagittatis ca. 0.6 cm. longis, filamentis 0.5 cm. longis rugoso-crispatis.—CHIRIQUÍ: Potrero Muleto, Volcán de Chiriquí, alt. 3500 m., July 13, 1940, *Woodson & Schery 379* (Herb. Missouri Bot. Gard., TYPE).

E. venusta is closely related to the group of rather dubious species centering about *E. reflexa* (Cav.) Rose, but differs from all in its conspicuously spathaceous bracts and somewhat larger flowers with longer pedicels. The species was very abundant at the type locality, and as charming as a planned floral display; it is well worthy of cultivation in northern greenhouses.

SMILACACEAE

(C. V. Morton[1]*)*

SMILAX **chiriquensis** Morton, sp. nov. Liana 7.5 m. longa, caulibus conspicue et argute quadrangularibus, pallide lutescentibus, glabris, parce aculeatis, aculeis rectis vel curvatis, basi latis; petioli elongati, usque ad 6 cm. longi, glabri, medio vel supra medium articulati; laminae foliorum ovatae, usque ad 19 cm. longae et 12 cm. latae, apice breviter apiculatae, majores basi cordatae, minores basi truncatae, omnes integrae, non lobatae, papyraceae, pallide virides, glabrae, 9-nerviae, nervis extimis marginalibus, venis secundariis perspicue reticulatis, utrinque elevatis; umbellae masculae in ramis axillaribus brevibus foliis suffultis, vel foliis valde reductis umbellis pseudoracemosis; pedunculus 1–3 cm. longus, glaber, complanatus, quam petiolus longior; receptaculum parvum; pedicelli 5–11 mm. longi, glabri; perianthium viride, segmentis linearibus, 8–9 mm. longis, ca. 1.5 mm. latis, recurvis, glabris; filamenta gracilia, ca. 6 mm. longa, antheris parvis, ca. 1.5 mm. longis; flores feminei ignoti.—CHIRIQUÍ: valley of the upper Río Chiriquí Viejo, March 22, 1940, *Peggy White 348* (U. S. Nat. Herb., no. 1,791,114, TYPE); same locality, April 3, 1938, *Gene White 59*; Bajo Mona, Boquete, alt. 1350 m., April 2, 1938, *M. E. Davidson 478*.

This species belongs to the section Hispidae of the revision of Killip and Morton. It may be distinguished from all the continental American species of that group by its sharply quadrangular stems, large, long-petioled leaves, large flowers, and minute anthers. The Davidson specimen was distributed as *S. Regelii* Killip & Morton, to which it is not closely allied. *S. Regelii* has the perianth segments only 3.5–5 mm. long (rather than 8–9 mm., as in *S. chiriquensis*) and the anthers are longer than the very short (1.2 mm.) filaments. In *S. chiriquensis* the anthers are very small, much shorter than the elongate filaments, these about 6 mm. long.

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DIOSCOREACEAE

(C. V. Morton)

DIOSCOREA STANDLEYI Morton—CHIRIQUÍ: vicinity of Bajo Chorro, alt. 1900 m., July 20-22, 1940, *Woodson & Schery 652* and *664*. Previously known from Costa Rica.

IRIDACEAE

NEOMARICA CAERULEA (Ker-Gawl.) Sprague—BOCAS DEL TORO: Little Bocas, July 16, 1941, *H. von Wedel 2546*. This species occurs naturally from the Guianas to southern Brazil, according to J. G. Baker (Handb. Irid.). Out of this range, it has been cited from cultivation in highland Costa Rica by Standley (Fl. Costa Rica). Consequently, whether the species is indigenous or an escape is open to question, although Mr. von Wedel usually is careful to limit his collections to apparently indigenous plants. The plant resembles a gigantic *Sisyrinchium* with scapes 1.5–2 m. tall and violet-blue flowers 5–6 cm. in diameter.

MUSACEAE

HELICONIA PSITTACORUM L.f. (*H. hirsuta* L.f. Suppl. 158. 1781; *H. cannoidea* L.Rich. Nova Acta Acad. Nat. Cur. **15**, suppl.: *pls. 9–10.* 1831; *H. aurantiaca* Ghiesbreght ex Lem. Ill. Hort. *pl. 332.* 1862; *H. straminea* (Griggs) Standl. Fl. C. Z. 75. 1928).—Unless one shares the rather naive faith in the constancy of *Heliconia* species suggested by some recent authors, one must assume great complexity for this species, particularly with regard to such characters as length of the peduncle and color of bracts and flowers. Fortunately, the species is common in Panama, and has been collected abundantly. *H. psittacorum* and *H. hirsuta* were published in the same work by the younger Linnaeus (Suppl. 158. 1781), and since they have not been combined previously, I am adopting the former as more expressive of the aspect of the plants.

HELICONIA ROSTRATA R. & P. (*H. pendula* Wawra, Oesterr. Bot. Zeitschr. **13**: 8. 1861; *H. curtispatha* Petersen in Mart. Fl. Bras. **3**^{3}: 15. 1890; *H. longa* Griggs, Bull. Torrey Club **31**: 446. 1904).—It is difficult to see why modern authors have failed to recognize the essential similarity of the plants bearing these names to the suggestive illustration published by Ruiz and Pavon (Fl. Peruv. **3**: *pl. 305.* 1802).

HELICONIA SUBULATA R. & P. Fl. Peruv. **3**: *pl. 303.* 1802. (*H. acum-*

inata L. C. Rich. Nova Acta Acad. Nat. Cur. **15**, suppl.: *pl. 11.* 1831; *H. psittacorum* L. f. var. β. *subulata* (R. & P.) Baker, Ann. Bot. **7**: 199. 1893).—A thoughtful interpretation of the illustrations, crude as they are, makes their association as synonyms quite inescapable for me.

HELICONIA VELLERIGERA Poeppig, Reise Chile **2**: 295. 1836; Peters. in Mart. Fl. Bras. **3**^{3}: 18. 1844; K.Sch. in Engl. Pflanzenreich **4**^{45}: 37. 1900. (*Bihai vellerigera* (Poeppig) O.Ktze. Rev. Gen. **2**: 685. 1891; Griggs, Bull. Torrey Club **4**^{2}: 318. 1915).—COCLÉ: El Valle de Antón, *Woodson & Schery 205, Allen 1818;* Las Minas, *Allen 2707;* PANAMÁ: Río Boquerón, *Hunter & Allen 659.* This is one of the most striking species of *Heliconia,* attaining a height of 3 meters, the long inflorescences pendulous and clothed with very dense and brilliantly ferruginous hairs about 1 cm. long (the brilliant scarlet bracts and upper peduncle occasionally somewhat glabrate).

The identification of the Panamanian plants with Poeppig's has not been entirely an easy matter, although a guiding principal in our dealings with highland Panamanian plants has been liberal consultation of the disused species of Peru enumerated by Ruiz & Pavon and Poeppig. The complicating factor in this instance was that *H. vellerigera* is not represented by exsiccatae in American herbaria which we have consulted, and was known to Poeppig, Petersen, and Schumann only from a fragment of an inflorescence in the herbarium at Vienna. Schumann undertook to key the species from others on the basis of a supposedly erect inflorescence, which was repeated by Griggs. Nevertheless, we were struck with the fact that both Petersen and Schumann took pains to describe the indument of the inflorescence as "*pili. .ad 1 cm. longi*" amplified by the former by the remark, "*Species incomplete cognita, sed vellere ad omnibus ceteris Heliconiis distinctissima,*" and we hopefully labelled our Panamanian specimens as *H. vellerigera.*

Faith in our rather intuitive use of the early Peruvian authors has recently been vindicated in this case by examination, through the kindness of Dr. Standley, of two photographs of *H. vellerigera* from Peru; one specimen, the type of Poeppig, preserved in the herbarium at Vienna, and the other, a recent collection (*Weberbauer 6764*) in the herbarium at Berlin. There can be scarcely a shadow of doubt that the plants of Panama and those of Peru are quite conspecific. Unfortunately, the label of Weberbauer's plant does not indicate whether the inflorescence was erect or pendulous, but the latter almost certainly must have been the case.

HELICONIA VILLOSA Kl. (*Heliconia nutans* Woods. Ann. Missouri Bot. Gard. **26**: 276. 1939).—CHIRIQUÍ: Volcán de Chiriquí, alt. 1500–2000 m., *Woodson, Allen & Seibert 968*; COCLÉ: north of El Valle, alt. 1000 m., *Allen 2167*. Intensive study of the Panamanian Heliconias has convinced me of the folly of continuing the tenuous specific distinctions current at present. The species undoubtedly are extremely variable in all but the most conservative criteria, and hybridization may be suspected in several instances. The specimens cited above agree in all essential particulars with the original description of *H. villosa* and the illustration by Petersen in the 'Flora Brasiliensis' (3^3: *pl. 4.* 1890). Particularly is this true with regard to the specimen from the Province of Coclé. The type of *H. nutans* (*Woodson, Allen & Seibert 968*) is merely a specimen with somewhat more numerous and smaller bracts. The indument is rather variable, and nearly glabrous specimens have been observed, particularly in the northern range of the species which appears to extend as far as Honduras.

ZINGIBERACEAE

RENEALMIA (*Scaposae-Racemosae*) **Arundinaria** Woods. sp. nov. Herba gracillima omnino glabra. Culmi foliiferi gracillimi 3–4 dm. alti. Folia longiuscule (0.5–1.0 cm.) petiolata angustissime oblongo-lanceolata basi apiceque attenuata 7–15 cm. longa 1.0–1.7 cm. lata superne minora; ligula angusta 3–6 cm. longa truncata vel obscure auriculata purpureo-marginata. Panicula racemiformis pauciflora; culmis gracillimis 5–7 cm. longis, vaginis ca. 5–6 oblongo-ovatis obtusis 1.25–1.5 cm. longis membranaceis; pedunculis 2.5–3.0 cm. longis 8–12-floris; bracteis ovatis vel ovato-lanceolatis 0.5–0.7 cm. longis pallide roseis. Flores ignoti. Capsula ovoidea 0.6–0.7 cm. longa coccinea; calyce anguste turbinato ca. 0.5 cm. longo; pedicello ca. 0.5 cm. longo.—DARIÉN: foothills of Garagará, Sambú basin, southern Darién, alt. 30–500 m., Feb., 1912, *Pittier 5597* (U. S. Nat. Herb., TYPE; Gray Herb., ISOTYPE).

Because of its narrow, grass-like leaves and short, few-flowered racemiform inflorescences, this species does not coincide with any other previously published with which I am familiar.

COSTUS FRIEDRICHSENII O. G. Peters. Bot. Tidsskr. **18**: 260. 1893. —This name should apply to the plants assigned to *C. argenteus* R. & P. in the third of this series (Ann. Missouri Bot. Gard. **26**: 277. 1939), as a result of my perhaps overly zealous eagerness to resuscitate the disused species of the 'Flora Peruviana.' The illustration

by Ruiz and Pavon certainly bears great similarity to our plants. Since the publication of my note, however, I have received for identification a Bolivian specimen (*Krukoff 10489*) which agrees even better with the illustration and which has such a strikingly distinctive silvery indument that Ruiz and Pavon's epithet is the involuntary one to describe it. Most fortunately, about the same time I received on loan the type specimen of *C. Friedrichsenii* from Berlin. The latter undoubtedly is the plant from Panama so frequently confused with *C. villosissimus*.

COSTUS LAEVIS R. & P. Fl. Peruv. **1**: 3. 1798 (*C. giganteus* O. Ktze. Rev. Gen. **2**: 687. 1891, non Ridl.; *C. maximus* K. Sch. in Engl. Pflanzenreich, **4**[46]: 405. 1904; *C. splendens* Donn. Sm. et Tuerckh. Bot. Gaz. **32**: 260. 1902; *C. Skutchii* Morton, Jour. Wash. Acad. Sci. **27**: 306. 1937).—The identification of this name of Ruiz and Pavon with the magnificent plants of Panama and southern Central America is made through an examination of the type specimen in the herbarium at Madrid and notes kindly supplied by Dr. Loesener of Berlin.

COSTUS RUBER Griseb. Cat. Pl. Cub. 256. 1866 (*C. formosus* Morton, Jour. Wash. Acad. Sci. **27**: 305. 1937; *C. spicatus* Jacq. according to many authors; *C. spiralis* (Jacq.) Roscoe, according to K. Sch. in Engl. Pflanzenreich, **4**[46]: 400. 1904).—CHIRIQUÍ: Puerto Armuelles, alt. 0–75 m., *Woodson & Schery 857*; San Bartolomé, *Woodson & Schery 886*; COCLÉ: El Valle, alt. 800–1000 m., *Allen 1825*; CANAL ZONE: Gold Creek, *Seibert 584*; Barro Colorado Isl., *Woodson & Schery 993*; DARIÉN: Pinogana, alt. 20 m., *Allen 938*. The identification of these plants with *C. ruber* is made quite positive by an examination of *Wright 1514*, from eastern Cuba, cited by both Grisebach and Schumann. The species is one of the most attractive and frequent of southern Central America, well characterized by its ordinarily red flowers and bracts, the latter with margins densely ciliate, and rather large obovate or oblanceolate leaves. It is difficult to understand how Schumann was able to harmonize *C. ruber* as represented by *Wright 1514* with Roscoe's excellent illustration of *C. spiralis* (Monandr. Pl. *pl. 79.* 1828), which shows with particular detail the characteristic obovate-oval leaves with subcordate-auriculate base of the latter. In addition, *C. spiralis* is quite glabrous in all parts.

COSTUS SCABER R. & P. Fl. Peruv. **1**: 2. *pl. 3.* 1798.—COCLÉ: near Cerro Turega, 650–700 m., *Woodson & Schery 202*; PANAMÁ: hills above Campana, 600–800 m., *Allen 1873*. Our plants agree closely

with a photograph of the type specimen in the Madrid herbarium, and with the published illustration. I believe that this species extends to the Chiriquí region, and probably hybridizes with *C. nutans* K. Sch. throughout its range.

Costus spiralis (Jacq.) Roscoe, Monandr. Pl. *pl. 79.* 1828.—bocas del toro: Old Bank Island, Chiriquí Lagoon, *H. von Wedel 2000*; Isla Colón, *von Wedel 2939*; Isla Bastimentos, *von Wedel 2899.* These specimens agree strikingly with Roscoe's illustration, particularly with regard to the leaf shape, as has been discussed in a preceding paragraph.

CANNACEAE

Canna flaccida Salisb.—bocas del toro: Isla Colón, March 30, 1940, *H. von Wedel 78.* A new record for Central America. Previously known to occur in coastal South Carolina, Georgia, and Florida; also in Cuba and Hispaniola. The islands of the Chiriquí Lagoon apparently contain numerous Antillean elements.

Canna glauca L.—bocas del toro: Old Bank Island, Chiriquí Lagoon, Feb. 5, 1941, *H. von Wedel 2001.* Apparently the first record for Central America. Previously known to occur in the Antilles, the Guianas, and northern Colombia.

MARANTACEAE

Calathea villosa Lindl. Bot. Reg. **31**: *pl. 14.* 1845 (*C. hirsuta* Standl. Jour. Wash. Acad. Sci. **15**: 4. 1925).—This correction serves to re-emphasize by so much the affinities of the Panamanian flora for that of northeastern South America.

Calathea (*Pseudophrynium-Scapifoliae*) **Allenii** Woods. sp. nov. Planta 1 m. alta. Folia longiuscule petiolata; lamina oblongo-elliptica basi rotundata apice abrupte subcaudato-acuminata 20–45 cm. longa 8–15 cm. lata supra nervo medio excepto glabra subtus nervo medio praecipue minute puberula, petiolo ad 25 cm. longo pilosulo parte superiore ad 5 cm. callosa tereti, vagina ad 10 cm. longa 4 cm. lata dorso margineque pilosulis. Spica late fusiformis 11–13 cm. longa 3.0–3.5 cm. crassa sessilis vel pedunculo dense pilosulo ad 4 cm. longo, bracteis (ca. 20–25) dense imbricatis oblongis inferne late ovalibus apice late rotundato-emarginatis frequenter cuspe minuto ad medium munitis 5.0–5.5 cm. longis 1.5–3.5 cm. latis luteis marginibus apiceque praecipue pilosulis glabratisve. Flores ascendentes fasciculati bracteolis oblongo-linearibus ad 4 cm. longis; ovario ca. 0.4 cm. longo apice villoso; sepalis anguste

oblongo-lanceolatis acutis ca. 3 cm. longis glabris; corolla lutea extus minute sparseque pilosula, tubo angustissimo ca. 3.5 cm. longo, lobis staminodioque ca. 1.0–1.3 cm. longis.—PANAMÁ: summit of Cerro Campana, alt. 800–1000 m., Sept. 1, 1940, *P. H. Allen 2218* (Herb. Missouri Bot. Gard., TYPE).

The rather narrowly fusiform, sessile or very shortly pedunculate spikes of this species are very distinctive, as are the peculiarly emarginate bracts.

CALATHEA ALLOUIA (Aubl.) Lindl. Bot. Reg. **14**: sub *pl. 1210.* 1828. (*Maranta Allouia* Aubl. Hist. Pl. Guian. **1**: 3. 1775; *C. grandifolia* Lindl. Bot. Reg. **14**: *pl. 1210.* 1827; *Phrynium cylindricum* Roscoe, Monandr. Pl. *pl. 40.* 1828; *Calathea cylindrica* (Roscoe) K. Sch. Engl. Pflanzenreich, **4**^{48}: 83. 1902; *C. macrosepala* K. Sch. loc. cit. 84. 1902).—After intermittent consideration for several years, I have come to the firm conviction that the showy plants of southern Central America and northern South America usually identified as *C. violacea* (Rosc.) Lindl. and *C. macrosepala* K. Sch. are quite conspecific and represent merely minor varieties with blue or pale yellow varieties respectively; nor is there much doubt in my mind that Aublet's name should be applied to them. Upon numerous occasions I have collected the two varieties growing intermixed, and Mr. Allen has confirmed my observations independently. The typical variety is that with the pale yellow flowers; that with blue flowers may be indicated as follows:

CALATHEA ALLOUIA (Aubl.) Lindl. var. **violacea** (Roscoe) Woods., comb. nov. (*Phrynium violaceum* Roscoe, Monandr. Pl. *pl. 37.* 1828).

CALATHEA (*Pseudophyrnium-Scapifoliae*) **foliosa** Rowlee, sp. nov. Planta submetralis et humilior. Folia folio 1 caulino excepto sub pedunculo ca. 7–10 dense rosulata, lamina oblongo-lanceolata apice breviter acuminata basi obtusa ad 32 cm. longa 8 cm. lata nervo medio subtus minute puberulo caeterum glabra, petiolo 1 cm. longo tota longitudine calloso, vagina angusta obtusa 15–20 cm. longa glabra. Spica globosa ca. 6 cm. diametro, pedunculo ca. 9 cm. longo glabro, bracteis ca. 25 plus minusve imbricatis late ovatis breviter acuminatis 2–3 cm. longis extus intusque dense tomentellis. Flores ut videntur gilvi fasciculati; ovario glabro; sepalis lanceolatis 3 cm. longis; corollae tubo 1.5 cm. longo lobis ellipticis 1 cm. longis staminodio elliptico 0.7 cm. longo.—BOCAS DEL TORO: Farm 6, near Almirante, Sept. 23, 1920, *N. W. Blair 1016* (U. S. Nat. Herb., TYPE).

This manuscript species of the late Prof. Rowlee appears to be most closely related to *C. indecora,* described in a previous paragraph of this report. The lower stature, acuminate bracts, and particularly the rosulate leaves render it distinctive. Rosulate cauline leaves have been reported previously for the genus in *C. Pearcei* Rusby, of Bolivia, with which *C. foliosa* can claim little close relationship.

Calathea (*Pseudophrynium-Scapifoliae*) **indecora** Woods., sp. nov. Planta valida 2.0–2.5 m. alta. Folia longe petiolata, lamina oblongo-elliptica basi rotundata apice breviter acuminata 40–65 cm. longa 14–22 cm. lata supra nervo medio puberulo caeterumque glabra subtus minute puberula, petiolo 20–45 cm. longo minutissime pilosulo parte superiore ad 4 cm. longa callosa tereti dense papillata, vagina 11–20 cm. longa haud auriculata. Spica late ovoidea 5–8 cm. longa, pedunculo valido 10–18 cm. longo superne puberulo, bracteis (ca. 15–30) latissime ovatis subrotundatis ca. 2 cm. longis latisque pallide viridibus dense pilosulis ad anthesim laceratis laxe patulis. Flores ad anthesim patuli; ovario 0.2 cm. longo glabro; sepalis anguste oblongis acutis 2 cm. longis glabris superne minutissime pilosulis; corollae lacteae glabrae tubo angustissimo ca. 2 cm. longo, lobis obovato-ellipticis 1.5 cm. longis, staminodio 1 cm. longo.—BOCAS DEL TORO: Isla Colón, Aug. 15, 1940, *H. von Wedel 476* (Herb. Missouri Bot. Gard., TYPE); Old Bank Island, Feb. 15, 1941, *von Wedel 2102*; Isla Colón, Oct. 18, 1940, *von Wedel 1229*; Water Valley, Sept. 11, 1940, *von Wedel 712.*

Dr. Schery and I were with Mr. von Wedel when the type specimens were collected in fairly low woods on Isla Colón. On the basis of dried plants alone I might otherwise have been deceived into identifying them as somewhat anomalous specimens of *C. Allouia,* with which it is doubtless closely related. The fine stand of plants that we saw, however, did not at all recall that species, so distinctive were they. *C. indecora* is a much taller, stouter plant, and the aspect of the spikes, with their roughly reflexed and spreading bracts and flowers, from which the specific adjective is derived, is quite distinctive amongst the species of the subgenus Pseudophrynium with which I am familiar.

Calathea (*Pseudophrynium-Scapifoliae*) **lagunae** Woods. sp. nov. Planta submetralis. Folia brevissime petiolata, lamina late rarissime anguste oblongo-elliptica non raro ovali 11–45 cm. longa 7–12 cm. lata utrinque glabra, petiolo 1.5–6.0 cm. longo tota longitudine calloso minute papillato, vagina 6–15 cm. longa obtusa haud

auriculata glabra. Spica ovoidea 3–6 cm. longa, pedunculo 10–17 cm. longo superne excepto glabro, bracteis ca. 10–15 imbricatis subreniformi-ovatis latissime obtusis vel rotundatis 1–2 cm. longis luteis praecipue basi dense pilosis. Flores ad anthesim ascendentes; ovario 0.2 cm. longo glabro; sepalis oblongo-ovalibus obtusis 2 cm. longis glabris; corollae albae glabrae tubo angusto 2 cm. longo, lobis late ellipticis 1.5 cm. longis, staminibus staminodioque ca. 1 cm. longis.—BOCAS DEL TORO: Western River, Sept. 19, 1941, *von Wedel 2706* (Herb. Missouri Bot. Gard., TYPE); Isla Colón, Oct. 23, 1940, *von Wedel 1328.*

Most closely related to *C. picta* Hook. f. (Bot. Mag. *pl. 7674.* 1899) of previously published species. This Brazilian species, published from a plant cultivated at Kew, however, is stated to be glabrous in all parts, and other discrepancies might be added.

CALATHEA MICROCEPHALA (Poepp. & Endl.) Koernicke, Bull. Soc. Nat. Moscow **35**[1]: 125. 1862 (*Phrynium microcephalum* Poepp. & Endl. Nov. Gen. & Sp. **3**: 20. *pl. 128, figs. a-b.* 1838; *Maranta micans* Mathieu, Cat. 1853; *C. micans* (Mathieu) Koernicke, loc. cit. 126. 1862; *C. albicans* Brongn. ex K. Sch. in Engl. Pflanzenreich **4**[48]: 112. 1902).—I have taken the opportunity to study this species upon several collecting trips to Panama, and have found it to be quite variable in all the key characters used by Petersen and Schumann to separate *C. microcephala, C. micans,* and *C. albicans,* notably height of plant, shape and size of leaves, and color of staminodia. Biologically speaking, I feel quite confident that a single species is represented.

CALATHEA PICTA Hook. f. Bot. Mag. *pl. 7674.* 1899.—COCLÉ: north of El Valle, alt. 1000 m., *Allen 2331*; PANAMÁ: summit of Cerro Campana, alt. 800–1000 m., *Allen 2219.* Mr. C. V. Morton and I can find no characters to separate Mr. Allen's specimens from the illustration of *C. picta.* This is somewhat embarrassing, since the species previously has been known only from a plant, supposedly from Brazil, which was cultivated at Kew.

STROMANTHE LUTEA (Jacq.) Eichl. Abhandl. Akad. Berlin **1882**: 81. 1883. (*Maranta lutea* Jacq. Collect. **4**: 117; Icon. *pl. 201.* 1794; *Myrosma Guapilesense* Donn. Sm. Bot. Gaz. **23**: 251. 1897).—I have been unable to distinguish Capt. Smith's species, ranging from Guatemala to Panama, from that of Jacquin, which occurs in Colombia, Venezuela, and northern Brazil. The former was overlooked by Schumann in his account of Marantaceae for the 'Pflanzen-

reich.' The problem of whether our plant is a *Myrosma* or a *Stromanthe* as applied by Schumann resolves largely into a question of whether the leaves are "antitropic" or "homotropic." This distinction of Eichler appears to me as extremely deceptive, if not artificial, as is shown by Schumann's rearrangement of Eichler's species amongst the same genera, upon the same criterion. I am inclined to disregard this dubious character in favor of others more easy to apply. From the same standpoint, I feel that *Stromanthe Tonckat* (Aubl.) Eichl. is very much better left in *Maranta* where it was placed by Aublet since its entire aspect and structure, exclusive of "homotropic" or "antitropic" orientation of the leaves, is indelibly suggestive of *M. arundinacea* L. *M. Tonckat* has been reported in Costa Rica, and is to be expected in Panama as well.

MYROSMA **dasycarpa** (Donn. Sm.) Woods., comb., nov. (*Calathea dasycarpa* Donn. Sm. Bot. Gaz. **31**: 123. 1901; *Ctenanthe dasycarpa* (Donn. Sm.) K. Sch. in Engl. Pflanzenreich, **4**^{48}: 153. 1902).—I can scarcely call myself an authority on Marantaceae, and feel a becoming sense of modesty in contradicting the generic concepts of an authority of Dr. Schumann's calibre. Nevertheless, I feel very strongly that several of his generic conceptions amongst the Maranteae in the 'Pflanzenreich' are extremely impractical. Foremost of these, as I have remarked in a previous paragraph, is the distinction between "homotropic" and "antitropic" leaves, of which Schumann even was somewhat wary (Pflanzenreich, loc. cit.). I do not have a large collection of living Maranteae available for observation; but whatever the situation in life, the leaf character is entirely inapplicable in the herbarium, and I am unwilling to perpetuate it in the 'Flora of Panama.' Therefore I am considering *Ctenanthe* Eichl. as a synonym of *Myrosma* L. f. I am not aware of any valid morphological characters to distinguish them.

ISCHNOSIPHON **Pittieri** (Rowlee) Woods., comb. nov. (*Pleiostachya Pittieri* Rowlee, ex Standl. Jour. Wash. Acad. Sci. **15**: 5. 1925).—Since I have made a start toward reforming the genera of Marantaceae as represented in the microcosm of Panama, the job might as well be made consistent. *Pleiostachya* has no observable distinction from *Ischnosiphon* save the compression of the bracts, as far as I am aware; other morphological characters appear to be fairly coherent. Fortunately, the other species currently treated as Pleiostachyas are both provided with combinations in *Ischnosiphon*: *I. pruinosus* (Reg.) Peters., and *I. Morlaei* Eggers.

BURMANNIACEAE

Apteria aphylla (Nutt.) Barnhart—bocas del toro: Old Bank Island, Feb. 17, 1941, *H. von Wedel 2111*. Previously known to occur from the southeastern United States to Bolivia.

ORCHIDACEAE

(Louis O. Williams)

Habenaria monorrhiza (Sw.) Reichb. f.—coclé: moist roadside banks, dry hills south of El Valle de Antón, alt. 600–800 m., flowers white, Nov. 13, 1941, *Allen 2771*. A not uncommon species found from Guatemala through Central America, south to Peru and in the West Indies. Apparently not reported for Panama.

Sobralia **Allenii** L. O. Williams, sp. nov. (pl. 30, figs. 1–3). Plantae caespitosae, epiphyticae, usque ad 5 dm. altae. Folia elliptico-lanceolata vel anguste elliptica, acuminata, plicata, 7-nervia. Inflorescentia terminalis, uniflora. Sepalum dorsale oblanceolatum, apiculatum. Sepala lateralia lineari-oblonga, apiculata. Petala oblanceolata, acuta, serrulata. Labellum oblongo-ovale, truncatum vel leviter retusum, lacerato-dentatum; discus carinis et callo bipartito ornatus, pubescens. Columna generis.

Caespitose epiphytic plants up to about 5 dm. tall. Stems about 1–2 mm. in diameter, slender, bearing 1–3 leaves toward the apex, leafless below or the leaves reduced to sheaths. Leaves 13–18.5 cm. long, 1.8–2.5 cm. broad, elliptic-lanceolate to narrowly elliptic, acuminate, plicate, with 7 principal nerves, lepidote on the lower surface especially along the nerves at the base, glabrous above or essentially so; leaf-sheaths closely appressed to the stem, lepidote. Inflorescence terminal, 1-flowered, flowers small, white with a pale yellow lip. Dorsal sepal about 3.5 cm. long, 7 mm. broad, oblanceolate, apiculate, 7-nerved. Lateral sepals about 3.5 cm. long, 7 mm. broad, linear-oblong, apiculate, 7-nerved. Petals about 3.5 cm. long, 6–7 mm. broad, oblanceolate, acute, terminal half serrulate, 7-nerved. Lip about 3.5 cm. long, 1.8 cm. broad, oblong-oval, truncate or shallowly retuse, terminal half lacerate-dentate; disc with several inconspicuous longitudinal carinae and with a small bipartite callus thickening at the base, pubescent longitudinally along the middle, especially toward the apex. Column of the genus, about 1.5 cm. long.—coclé: epiphytic, trail to La Mesa, hills north of El Valle de Antón, alt. ca. 1000 m., (sepals and petals white, labellum pale yellow), Aug. 31, 1941, *Allen 2686* (Herb. Ames, type).

Sobralia Allenii is most closely allied to *S. mucronata* A. & S. from which, however, it is distinguished by the pubescent lip which is lacerate-dentate in the terminal half. The leaf-sheaths and leaves of *S. Allenii* are lepidote, while those of *S. mucronata* are glabrous or essentially so.

Description and illustration from a dried specimen and a flower in liquid.

Sobralia decora Batem. var. **aerata** Allen & Williams, var. nov. (pl. 31). E specie planta parviore et floribus aeratis differt.—COCLÉ: bad lands south of El Valle de Antón, alt. ca. 500 m., Sept. 18, 1941, (flowered in collection of A. M. Bouché, Pedro Miguel, C. Z.), *Allen 2755* (Herb. Ames, TYPE); ravines in bad lands south of El Valle de Antón, alt. ca. 600 m., (flowered in collection of Mr. and Mrs. Barrett, Bas Obispo, C. Z.), *Allen 2846*.

In the field this plant appears to be amply distinct from *Sobralia decora* Batem., but herbarium study indicates that it is perhaps only a variety. The plants average about 5 dm. tall while *S. decora* is commonly 2–2.5 m. tall. The flower color is quite distinctive: sepals greenish on the outer surfaces, very near Brick Red within; petals a washed Brick-Red with lighter margins and median line dorsally; lip Brick Red dorsally with a white median line and white margins, —the inner surface is very nearly Acajou Red with upper margins white and with an Amber Brown median stripe; the column is pure white. [Ridgeway colors]. The local name for this variety is "Bronze Sobralia," hence the varietal name, meaning "ornamented with bronze."

Spiranthes **navarrensis** (Ames) L. O. Williams, comb. nov. (*Stenorrhynchus navarrensis* Ames, Sched. Orch. **9**: 13, *t. 3.* 1925).—CHIRIQUÍ: cloud forest, Cerro Horqueta, alt. ca. 2000 m., (flowers yellow), June 2, 1940, *von Hagen & von Hagen 2111.* New to the flora of Panama, previously known from Costa Rica. Closely allied to *Spiranthes speciosa* (G. F. Gmel.) A. Rich.

Spiranthes **Woodsonii** L. O. Williams, sp. nov. Herbae palustres, terrestres, usque ad 5.5 dm. altae. Caules graciles, basi foliosi. Folia oblongo-elliptica vel ovalia, acuta vel obtusa. Sepalum dorsale lanceolatum, acuminatum. Sepala lateralia in mentum saccatum producta, lanceolata, acuminata, arcuata. Petala elliptica vel anguste oblanceolata, acuta acuminatave. Labellum lineari-oblongum, panduratum et caudatum, apice leviter expansum. Columna sectionis (§ Sarcoglottis).

Terrestrial, palustrine herbs from underground rhizomes, up to

5.5 dm. tall. Rhizome slender, rooting at most of the nodes, with scarious sheaths arising from the nodes. Stem slender, with well-developed leaves at the base which become bract-like above. Leaves 3–10 cm. long, 1.3–2.8 cm. broad, oblong-elliptic to narrowly oval, acute or obtuse, largest near the base of the stem and reduced to amplexicaul bracts above. Inflorescence up to 10 cm. long, congested in flower, becoming more open in fruit; bracts up to 4 cm. long, 1.6 cm. broad, lanceolate, acuminate, pubescent dorsally. Flowers large, similar to those of *S. acaulis*. Dorsal sepal 16.5–19 mm. long, 3.5–4 mm. broad, lanceolate, acuminate, 3–5-nerved, densely pubescent dorsally. Lateral sepals long-decurrent on the ovary, 35–40 mm. long from the apex to the base of the saccate mentum; free part 16.5–19 mm. long, 4–4.5 mm. broad, lanceolate, acuminate, arcuate, spreading, densely pubescent dorsally, 3–5-nerved. Petals 15–18 mm. long, 2–2.5 mm. broad, narrowly elliptic to narrowly oblanceolate, acute or acuminate, arcuate, adherent to the dorsal sepal, pubescent on the margins, the basal half ciliate. Lip 28–32 mm. long, 6–7 mm. broad (apical lobe), linear-oblong, caudate, somewhat expanded and pandurate, with two extremely pubescent, converging callus-ridges on the terminal third, the basal part densely pubescent and the remainder, except the glabrous apex, less pubescent, glabrous below except at the base; terminal lobe transversely oval or transversely rhombic; caudae about 5 mm. long, retrorse, fleshy but flattened. Column (free part) about 8 mm. long, pubescent at the base ventrally; rostellum oblong-lanceolate, obtuse, flattened. Ovary densely pubescent.—CHIRIQUÍ: vicinity of Boquete, alt. 1200-1500 m., (flowers pale green), July 24-26, 1940, *Woodson & Schery 753* (Herb. Ames, TYPE); in swampy meadows, Finca Lérida to Boquete, alt. ca. 1300-1700 m., (flowers pale yellowish green), July 8–10, 1938, *Woodson, Allen & Seibert 1148*.

Spiranthes Woodsonii is not very closely allied to any Central American species of the genus. It belongs in the section Sarcoglottis. The species is particularly distinctive in having a creeping underground rhizome or stem instead of the usual fascicle of fleshy roots. In flower structure *Spiranthes Woodsonii* approaches *S. acaulis* (J. E. Sm.) Cogn. (*S. picta* (Anders.) Lindl.) but in detail is amply distinct.

STELIS **Allenii** L. O. Williams, sp. nov. (pl. 32, figs. 1–3). Herbae caespitosae, epiphyticae, usque ad 4 dm. altae. Folia elliptica vel elliptico-ovalia, acuta vel obtusa. Inflorescentia elongata; bracteae ovato-lanceolatae, acutae vel acuminatae, infundibuliformes. Sep-

alum dorsale lanceolatum, acutum, cucullatum. Sepala lateralia connata, suborbiculari-ovata, acuta vel obtusa, cucullata et gibbosa. Petala late flabellata vel transverse ovalia. Labellum flabellatum, truncatum, apice callo transverso ornatum.

Large caespitose epiphytic herbs up to 4 dm. tall. Secondary stems 7–15 cm. long, 0.25–0.35 cm. in diameter, covered with 2 or 3 loose sheaths which soon disintegrate, shorter than the leaves. Leaves 10–19 cm. long, 3.5–7 cm. broad, elliptic to elliptic-oval, acute or obtuse, coriaceous, attenuated into a short petiole at the base. Inflorescence up to 30 cm. long, floriferous to the base, 1 or more borne from the apex of the stems (if more than 1 then presumably borne in different years); sheaths up to 2.5 cm. long, cucullate, ample; bracts 2–18 mm. long, reduced upward, ovate-lanceolate, acute or acuminate, infundibuliform. Flowers largest of the genus. Dorsal sepal 14–16 mm. long, 5–6 mm. broad, lanceolate, acute, 11–13-nerved, cucullate. Lateral sepals connate to their apices, together 10–12 mm. long and 8–10 mm. broad, suborbicular-ovate, acute or obtuse, cucullate and gibbous at the base, many-nerved. Petals about 1 mm. long, 1.5 mm. broad, broadly flabellate to transversely oval, the apex much thickened. Lip 0.75–1 mm. long, 1–1.4 mm. broad, about 0.75 mm. thick at the apex, flabellate, truncate, with a transverse callus at the apex of the lip,—very like the petals but slightly smaller.—COCLÉ: hills north of El Valle de Antón, alt. 800 m., (flowers nearly black), April 10, 1942, *Allen 2952* (Herb. Ames, TYPE).

Stelis Allenii is perhaps the most distinctive species of this difficult genus in Central America and seems to be the largest-flowered species of the genus. There are no near allies in Central America but the species seems to belong to Lindley's section Dialissa, a section with but a few species in the Andes.

STELIS **atrorubens** L. O. Williams, sp. nov. (pl. 32, figs. 4–8). Herbae epiphyticae, caespitosae, parvae, usque ad ca. 18 cm. altae. Folia petiolata; lamina elliptica vel elliptico-oblanceolata, obtusa. Inflorescentia densiflora, quam folia longiora. Sepala basi connata, rotata, triangularia, acuta. Petala suborbicularia, carnosa. Labellum obscure trilobatum, oblongum vel oblongo-ovale, carnosum.

Small caespitose epiphytic herbs up to about 18 cm. tall. Secondary stems 1.5–3.5 cm. long, slender, covered with sheaths. Leaves 6–9 cm. long, petiolate, much longer than the secondary stems; lamina about 4–6.5 cm. long, 0.5–1 cm. broad, elliptic to elliptic-oblanceolate, obtuse, fleshy; petiole 2–3 cm. long. Inflorescence up

to 15 cm. long, upper half more or less densely flowered; bracts about 2 mm. long, infundibuliform, acute, scarious. Sepals connate at the base, rotate, 2–2.5 mm. long, 1.5–2 mm. broad, triangular, acute, 3-nerved. Petals about 0.75 mm. long, 0.75 mm. broad, suborbicular, 1-nerved, the terminal part thickened, fleshy. Lip 1–1.5 mm. long, 0.5–0.6 mm. broad, obscurely 3-lobed, oblong or oblong-oval, basal part of the lip oblong, somewhat concave, fleshy, terminating into two small, suberect lateral lobes,—terminal lobe of the lip about 0.5 mm. long, suborbicular, strongly concave, fleshy.—COCLÉ: vicinity of El Valle, alt. 600–1000 m., Dec. 8, 1938, *Allen 1234;* hills north of El Valle de Antón, trail to Las Minas, (flowers maroon), Dec. 2, 1941, *Allen 2876* (Herb. Ames, TYPE).

Stelis atrorubens is allied to *S. montana* L. Wms., but differs in several details. The flower parts of *S. montana,* a species not previously illustrated, are figured in pl. 32, figs. 9–12, for comparison.

STELIS MONTANA L. Wms. in Ann. Mo. Bot. Gard. **27**: 272. 1942.—Figures of this distinctive and unusual species are given in pl. 32, figs. 9–12.

CRYPTOPHORANTHUS **lepidotus** L. O. Williams, sp. nov. (pl. 30, figs. 4–7). Herbae caespitosae, epiphyticae, usque ad ca. 17 cm. altae. Folia oblanceolata vel anguste obovata, obtusa vel acuta, coriacea, petiolata. Sepala basi et apice connata; sepalum dorsale oblongo-oblanceolatum, cucullatum, carnosum; sepala lateralia usque ad apicem connata. Petala late ovato-lanceolata, acuta vel acuminata. Labellum hastatum, unguiculatum; lamina verrucosa vel lepidota. Columna generis.

Caespitose epiphytic herbs up to about 17 cm. tall. Secondary stems 2–7 cm. long, 1–2 mm. in diameter, covered with 4–5 pergameneous, infundibuliform sheaths which soon disintegrate. Leaves oblanceolate to narrowly obovate, obtuse or acutish, coriaceous, contracted into a distinct petiole; lamina 3.5–10 cm. long; petiole 1–2 cm. long, conduplicate. Inflorescence a fascicle of 1–6 long pedunculate flowers at the apex of the secondary stem; the peduncle with 1–3 short infundibuliform sheaths. Sepals joined at the base and at the tip leaving a small opening between the dorsal and lateral sepals; dorsal sepal about 15–20 mm. long, 6–7 mm. broad, oblong-oblanceolate, strongly cucullate, fleshy, 7-nerved, ridged dorsally, the ridges verrucose; lateral sepals connate to their apices, about 12–18 mm. long and together 6–8 mm. broad, fleshy, each about 7-nerved, with verrucose ridges dorsally. Petals 5–6 mm. long, 2.5–3.5 mm. broad, broadly ovate-lanceolate, acute or acuminate,

3(–5)-nerved. Lip 5–6 mm. long, the lamina about 4 mm. long, 1.5–2 mm. broad, hastate, unguiculate, 3-nerved, verrucose or lepidote, with two longitudinal, lamellate calluses extending from the auricles to about the middle; auricles about 1 mm. long, retrorse, subulate; claw 1.5–2 mm. long, 1–1.5 mm. broad, verrucose-scurfy or lepidote toward its apex. Column of the genus.—COCLÉ: epiphytic, trail to Las Minas, hills north of El Valle de Antón, alt. ca. 1000 m., (lower sides of many of the leaves deep purple, flowers white with very heavy purple stripes), Sept. 1, 1941, *Allen 2718* (Herb. Ames, TYPE).

Cryptophoranthus lepidotus is apparently somewhat allied to *C. beloglottis* Schltr. from Ecuador but it is easily distinguished by the smaller, differently shaped leaves as well as by the details of the flowers. *Cryptophoranthus Endresianus* Kränzl. is not well described but the available record indicates that it differs from *C. lepidotus.* Kränzlin's monograph of *Cryptophoranthus* (in Fedde Repert. Beih. **34**: 220–232. 1925) omits several species of this genus published prior to the date of the monograph.

LEPANTHES LINDLEYANA Oerst. & Reichb. f.—This name has been taken up for a not-uncommon species of Costa Rica and Panama. Reichenbach illustrated the species but his illustration does not coincide too well with the plants referred here. The plant usually identified as *L. Lindleyana* has a name which seems to refer to it exactly, *Lepanthes chiriquensis* Schltr. In the original description of *L. Lindleyana* the petals are described as "Tepala dimidiata triangula angulo inferiori obtusata, ciliolata," and in the illustration the petals might be considered to fit this characterization rather loosely. The petals, if bipartite, have a large anterior lobe and no posterior lobe; the dorsal sepal is as broad as the combined laterals; the lip shows no apiculation or mid-lobe.

PLEUROTHALLIS **antonensis** L. O. Williams, sp. nov. Herbae caespitosae, epiphyticae, usque ad 3 dm. altae. Folia lanceolato-cordata vel late cordata, acuta vel acuminata, coriacea. Inflorescentia fasciculata, uni- vel pauciflora. Sepalum dorsale elliptico-obovatum, obtusum vel acutum. Sepala lateralia connata, ovata vel late ovata, obtusa vel acuta. Petala lineari-oblonga, acuta, serrulata, arcuata. Labellum unguiculatum; lamina cordata vel oblongo-cordata, denticulata; unguis brevis. Columna generis.

Caespitose epiphytic herbs up to about 3 dm. tall. Secondary stems slender, with one or two scarious sheaths at the base, naked above. Leaves 4–9 cm. long, 1.5–4.7 cm. broad, lanceolate-cordate to

broadly cordate (young leaves elliptic), acute or acuminate, coriaceous. Inflorescence a 1–several-flowered fascicle from the apex of the secondary stems, much shorter than the subtending leaves. Dorsal sepal 6–7.5 mm. long, 3–4 mm. broad, elliptic-obovate, obtuse or acute, 3-nerved. Lateral sepals connate to their apices, 5.5–7 mm. long, 4–5 mm. broad, ovate or broadly ovate, obtuse or acute, 6-nerved. Petals 3.8–4.5 mm. long, 0.6–1 mm. broad, linear-oblong, acute, serrulate, strongly arcuate, 1-nerved. Lip unguiculate; lamina 2.5–3 mm. long, 2–2.5 mm. broad, cordate to oblong-cordate, denticulate, fleshy, the surface obscurely verrucose or smooth, with a small central cavity near the base; claw short. Column about 1 mm. long.—COCLÉ: hills north of El Valle de Antón, alt. ca. 1000 m., (flowers light brown), July 23, 1940, *Allen 2156;* same locality, July 14, 1940, *Allen 2194;* same locality, Nov. 21, 1940, *Allen 2267;* same locality, Sept. 1, 1941, *Allen 2701* (Herb. Ames, TYPE); mountains beyond La Pintada, alt. 400–600 m., Feb. 17, 1935, *Hunter & Allen 594.*

Pleurothallis antonensis has been referred to *P. phyllocardia* Reichb. f., a rather obscure and poorly described species. We have an analysis of *P. phyllocardia* which shows the lip to be about one-fourth the length of the lateral sepals, while in *P. antonensis* the lip is half as long as the sepals. The lateral sepals of *P. phyllocardia* are about as broad as the dorsal sepal and the petals are only slightly arcuate, while in *P. antonensis* the lateral sepals are broader than the dorsal sepal and the petals are strongly arcuate.

The specific name recalls El Valle de Antón which, apparently, has a very large number of endemic species of orchids.

PLEUROTHALLIS ARISTATA Hook. in Ann. & Mag. Nat. Hist. **2**: 229, *t. 15.* 1839. *(P. dichotoma* Ames, Sched. Orch. **6**: 58. 1923, non Schltr.; *P. divexa* Ames. Sched. Orch. **7**: 20, *t. 5.* 1924).

Costa Rica, Panama, the West Indies and British Guiana.

Pleurothallis Urbaniana Reichb. f. has been considered to be the same as the two synonyms cited (Schweinfurth in Bot. Mus. Leafl. Harv. Univ. **6**: 36. 1938) but no authentic material or record is available and the description shows some discrepancies. Known only from Chiriquí in Panama *(Davidson 187).*

PLEUROTHALLIS BRIGHAMII S. Wats. in Proc. Am. Acad. **23**: 285. 1888; Ames, Sched. Orch. **2**: 18. 1923; **7**: 19, *t. 7.* 1924. *(P. periodica* Ames, Sched. Orch. **7**: 21, *fig. 4.* 1924; *P. acrisepala* A. & S. Sched. Orch. **8**: 22. 1925; *P. barboselloides* Schltr. in Fedde Repert. Beih. **17**: 18. 1922; **59**: *t. 29, fig. 113.* 1931).

In attempting to separate and describe the various species cited above for the account of the Panamanian flora it was found that, as a whole, they formed a most complete series.

Pleurothallis pyrosodes Reichb. f. is of this alliance. It is known to me only by the description and a rather rough analysis of the type but it may prove to be the same and if so it will include all of the above names as synonyms. *Pleurothallis Brighamii,* as now constituted, is a species of low elevations, perhaps not exceeding 400 m., which extends from Guatemala to Panama.

Pleurothallis **cardiochila** L. O. Williams, sp. nov. (pl. 33, figs. 8–10). Herbae caespitosae, epiphyticae, usque ad ca. 21 cm. altae. Folia lanceolato-cordata, acuminata, coriacea. Inflorescentia fasciculata, uni(-pauci)-flora. Sepalum dorsale oblongo-ovale, obtusum, cucullatum. Sepala lateralia connata, ovata, acuta. Petala lineari-oblonga, acuta, basi subauriculata. Labellum unguiculatum; lamina suborbiculari-cordata, obtusa; unguis oblongus. Columna generis.

Small caespitose epiphytic herbs up to about 21 cm. tall. Secondary stems up to about 11 cm. long, slender, with 1–2 loose, chartaceous sheaths toward the base, naked above. Leaves 9–10 cm. long, 3.6–3.9 cm. broad, lanceolate-cordate, acuminate, coriaceous. Inflorescence a 1(-few ?)-flowered fascicle subtended by a chartaceous sheath about 1–1.5 cm. long, much shorter than the leaves. Flowers very large for the group, yellowish with the dorsal sepal tinged with dark red, lip deep orange. Dorsal sepal about 20 mm. long, 12.5 mm. broad, oblong-oval, obtuse, with 7–9 principal nerves, strongly cucullate. Lateral sepals connate to their apices, about 18 mm. long, 10 mm. broad, ovate, acute, with 7–9 principal nerves. Petals about 13 mm. long, 2.5 mm. broad, linear-oblong, acute, arcuate, subauriculate on the posterior margin at the base, entire, 3-nerved at the base, the posterior nerve short, anterior nerve branched near the base,—hence the apical part of the petal 3-nerved. Lip unguiculate; lamina about 6 mm. long, 5.5 mm. broad, suborbicular-cordate, obtuse, callus-thickened along the sinus and below at the subapiculate apex, 3-nerved; claw about 2 mm. long, oblong. Column about 3 mm. long; clinandrium lacerate-digitate.—CHIRIQUÍ: rain forest, Bajo Chorro, Boquete District, alt. ca. 1800 m., Jan. 13, 1938, *Davidson 119* (Herb. Ames, TYPE).

Pleurothallis cardiochila is most nearly allied to *P. palliolata* Ames, from which it is easily distinguished by the suborbicular-cordate lip and by the 3-nerved, entire petals.

Pleurothallis **ellipsophylla** L. O. Williams, sp. nov. (pl. 33, figs. 1–7). Herbae parvae, repentes vel caespitosae, usque ad 2 dm. altae. Folia late elliptica vel elliptico-oblonga, acuta vel obtusa. Inflorescentia uni- vel pluriracemosa, racemis quam folia brevioribus. Sepalum dorsale anguste lanceolatum vel elliptico-oblanceolatum, acutum vel acuminatum. Sepala lateralia in laminam connata; lamina lanceolata, acuta vel subaristata. Petala elliptica vel elliptico-lanceolata, acuta vel acuminata, prope medium denticulata vel denticulato-lacerata. Labellum lanceolatum, acutum vel subaristatum, basi biauriculatum; unguis perbrevis; lamina prope basem callo V-formi ornata.

Small repent or caespitose epiphytic herbs up to about 2 dm. tall. Secondary stems up to 9.5 cm. long, prominently angled when dry, with one or more loose sheaths covering the lower part. Leaves 4–9.5 cm. long, 0.7–2.7 cm. broad, elliptic to elliptic-oblong, acute or obtuse, epetiolate, coriaceous. Inflorescence 1 or several short, few-flowered racemes from the axil of the leaf, approximately half as long as the leaf. Dorsal sepal 9–14 mm. long, 1.5–2.5 mm. broad, narrowly lanceolate to elliptic-oblanceolate, acute or acuminate, cucullate, 3-nerved, puberulent dorsally. Lateral sepals 10–13 mm. long and together 3–4 mm. broad, connate except at the tip, the lamina lanceolate, acute or subaristate, puberulent dorsally, gibbous and with a mentum at the base, 6-nerved. Petals 5.5–6.5 mm. long, 1.4–2 mm. broad, elliptic or elliptic-lanceolate, acute or acuminate, arcuate, denticulate or denticulate-lacerate toward the middle but the base and apex usually entire, 1-nerved. Lip 4–5 mm. long and 1–1.3 mm. broad, lanceolate, acute or subaristate, somewhat fleshy, prominently biauriculate at the base, claw very short, lamina with an inconspicuous V-shaped callus on the basal third. Column about 3 mm. long, with a narrow wing and two erect teeth at the apex; column-foot very short.—Bocas del Toro: epiphyte, southwest of Bocas at Maccaw Hill, Isla Colón, alt. 0–125 m., (flowers greenish-brown), Aug. 25, 1940, *H. von Wedel 560* (Herb. Ames, type); Río Cricamola, between St. Louis and Konkintöe, alt. ca. 10–15 m., ("labellum and hood greenish-yellow, striped with brown"), Aug. 12–16, 1938, *Woodson, Allen & Seibert 1884.*

Pleurothallis ellipsophylla is allied to *P. vittata* Lindl. and to *P. geminicaulina* Ames. From the former it is distinguished by larger flowers with comparatively narrow lip which lack lateral auricles or lobes; from *P. geminicaulina* it is distinguished by the compara-

tively longer and narrower lip with more prominent basal auricles, but lacks the parallel carinae of the lamina.

PLEUROTHALLIS OCTOMERIAE Schltr. in Fedde Repert. Beih. **17**: 21. 1922. *(P. cerea* Ames, Sched. Orch. **4**: 19. 1923; **7**: 26, *fig. 4* and *t. 8* in part. 1924).—COCLÉ: epiphytic, hills north of El Valle de Antón, trail to Las Minas, alt. ca. 1000 m., (sepals and petals pure white with narrow bright red margin, anther-cap red), Sept. 1, 1941, *Allen 2719.*

Pleurothallis octomeriae and *P. cerea* have flowers that are identical but the leaves on the types of the two species differ markedly in size, those of *P. octomeriae* varying from 4 to 14 cm. long and from 1 to 2.5 cm. broad while the single imperfect leaf known for *P. cerea* is "17 cm. or more long, 6.3 cm. wide." In both the shape of the leaf is essentially elliptic. In the collection cited above *(Allen 2719)*, of which there are four excellent specimens, the extremes of leaf sizes are 8 and 17 cm. long and 1.7 and 6 cm. broad. This indicates that the leaf size in the two proposed species is not specific and that they should be treated as one.

EPIDENDRUM PHYSODES Reichb. f.—BOCAS DEL TORO: terrestrial, vicinity of Chiriquí, Oct. 9, 1940, *H. von Wedel 1126.* New to Panama, previously known from Mexico, Guatemala and Costa Rica.

CATTLEYA SKINNERI Batem. var. **autumnalis** P. H. Allen, var. nov. Herbae epiphyticae vel saxicolae. Labellum concolor vel subconcolor. E specie planta robustior et floribus in autumno differt.

Differs from the species in that it is a somewhat more robust plant which flowers in the autumn. The lip usually lacks the white spot.—PANAMÁ: vicinity of Bejuca, alt. ca. 30 m., Aug. 15, 1941, *Allen 2668* (Herb. Ames, TYPE); east of [Panama] City, fall 1915, *Powell 16;* CANAL ZONE: along Caño Quebrada, Oct. 30, 1914, *Pittier 6828.*

Endemic to Panama where the species, a plant of higher elevations, does not occur (unless possibly in the mountains of Chiriquí).

Platyglottis L. Wms. gen. nov.

Platyglottis L. O. Williams gen. nov. (Orchidaceae-Monandrae-Acrotonae-Kerosphaereae-Acranthae-Ponereae). Herbae epiphyticae, caespitosae, e rhizomate perbrevi. Caules graciles, non pseudobulbosi, indurati, simplices. Folia disticha, coriacea. Inflorescentia terminalis (vel subterminalis ?), racemosa. Sepala petalis

subaequalia vel petala latiora. Labellum apice columnae pedi articulatum; lamina late ligulata, integra. Columna brevis, clavellata, exalata, basi in pedem brevem producta; anthera terminalis, operculata, incumbens, sex-loculata; pollinia 6($\genfrac{}{}{0pt}{}{00}{0000}$), aequalia cerea.

Epiphytic caespitose herbs from a very short rhizome. Stems slender, non-pseudobulbous, indurated, simple. Leaves alternate, distichous, coriaceous, plane, deciduous, leaf-sheaths tightly enfolding the stem. Inflorescence terminal (or subterminal?), racemose. Sepals subequal; dorsal sepal free; lateral sepals adnate to the short column-foot at their bases and with it forming an inconspicuous mentum. Petals similar to the sepals or broader. Lip articulated to the apex of the column-foot; lamina broadly ligulate, entire. Column short, clavellate, wingless, produced into a short foot at the base; anther terminal, operculate, incumbent, 6-loculate; pollinia 6, equal,—four basal in one laterally compressed series,—two terminal in a second laterally compressed series, ceraceous.

A single species known only from the vicinity of El Valle de Antón, Coclé Province, Panama.

The Ponereae is a small tribe of orchids the genera of which are limited to the American tropics or subtropics. The twelve genera of the tribe which seem to be recognizable are, with one exception, small with about six or fewer species each. Vegetatively these genera are divisible into two approximately equal series: (1) those with elongated stems and distichous leaves scattered along the stem; and (2) those with swollen or pseudobulbous stems upon which the leaves are terminal. These two groups may be further divided by various means.

The Brazilian genus *Orleanesia* Rodr., which I know only from a plate and descriptions, seems to approach *Platyglottis* in vegetative characters more than do the other genera of the tribe. Thus *Orleanesia*, which has two small and two large pollinia and apparently other technical characters, is easily separated from *Platyglottis*.

The other genera which approach *Platyglottis* in vegetative characters, *Jacquiniella* Schltr., *Ponera* Lindl., *Neourbania* Fawc. & Rendle, *Isochilus* R. Br. and *Octadesmia* Benth., may be quickly distinguished by the technical characters of the pollinia,—all having four pollinia except *Octadesmia* which has eight. *Platyglottis* is the only genus of this alliance which has six pollinia. However, six pollinia are not uncommon in the genus *Scaphyglottis* Poepp. &

Endl. *(sens. lat.)* which belongs in the series of the tribe having thickened stems or pseudobulbs.

PLATYGLOTTIS **coriacea** L. O. Williams, sp. nov. (pl. 34). Herbae epiphyticae, caespitosae, usque ad ca. 4.5 dm. altae. Folia anguste ligulata, obtusa, coriacea. Inflorescentia racema brevis, pauciflora. Sepalum dorsale lanceolatum, acutum vel acuminatum. Sepala lateralia lanceolata, acuta vel acuminata, leviter obliqua. Petala elliptico-oblanceolata, leviter obliqua. Labellum late ligulatum, subpanduratum, integrum, apice rotundatum. Columna generis.

Epiphytic caespitose herbs up to about 4.5 dm. tall. Stems 5–8 mm. in diameter, slender, leafy, becoming naked with age. Leaves 2.5–6 cm. long, 1–1.5 cm. broad, narrowly ligulate, obtuse, obscurely and unequally bilobed at the apex, coriaceous, distichous, deciduous. Inflorescence a short, few-flowered raceme, terminal (or subterminal?); bracts 7–20 mm. long, elliptic-lanceolate, acute, cucullate. Flowers large for the Ponereae, sepals and petals lavender, the lip lavender with greenish margins. Dorsal sepal about 10 mm. long, 3.5 mm. broad, lanceolate, acute or acuminate, 5(–7)-nerved. Lateral sepals about 10 mm. long, 3 mm. broad, lanceolate, acute or acuminate, slightly oblique, 5-nerved. Petals about 10 mm. long, 3.5 mm. broad, elliptic or elliptic-oblanceolate, somewhat oblique, obscurely constricted near the apex, 5(– 7)-nerved. Lip about 10 mm. long and 5 mm. broad near the apex, broadly ligulate, subpandurate, entire, apex rounded, margins thin and plicate laterally; disc fleshy, with a pair of inconspicuous, subumbonate calluses at the base. Column of the genus, about 4 mm. long.—COCLÉ: region north of El Valle de Antón, alt. ca. 1000 m., Feb. 20, 1942, *Allen 2936* (Herb. Ames, TYPE).

Described and illustrated from a herbarium specimen and flowers preserved in alcohol.

COELIOPSIS HYACINTHOSMA Reichb. f.—COCLÉ: epiphytic, hills north of El Valle de Antón, alt. ca. 1000 m., (inflorescence pendant, sepals and petals creamy white, labellum creamy white with yellow blotch near base of column), April 12, 1941, *Allen 2402*.

The original specimens were grown in England from material presumed to have been collected in Panama. Three collections, at least, have been made subsequently in Costa Rica but this is the first specimen known from a definite locality in Panama.

KEGELIELLA **Houtteana** (Reichb. f.) L. O. Williams, comb. nov. *(Kegelia Houtteana* Reichb. f. in Bot. Zeit. **10**: 670. 1852; Xenia

Orch. **1**: 45, *t. 20, I, 1–7.* 1854).—COCLÉ: vicinity of La Mesa, region north of El Valle de Antón, alt. 1000 m., Oct. 10, 1941, *Allen 2759.*

Kegeliella is a genus so extremely rare that but a single specimen previously had ever been received at the Ames Herbarium, and that from Jamaica. Mansfeld (Fedde Repert. **36**: 60. 1934) described an additional species of the genus from Costa Rica and called attention to the fact that *Kegelia* Reichb. f. was a homonym. It is apparent from Mansfeld's discussion that the genus was unrepresented in the Berlin herbarium until he received that specimen.

Kegeliella Houtteana was originally described from garden material that was said to have been discovered in Surinam. In repeating his description two years later in 'Xenia Orchidacea' Reichenbach wrote "Es ist sehr wahrscheinlich, dass die Mutterpflanze—von der Tracht einer Cirrhaea—aus Surinam stammt und von Herrn Kegel entdeckt wurde," which may indicate that he has some reason to doubt his previous statement of locality.

Reichenbach's drawing of his *Kegelia Houtteana,* like so many of his drawings, shows enough to recognize the genus but is not definite enough for one to be able to state that a specimen in hand is, without doubt, conspecific. There are some differences in the flowers of the Allen specimens and the only other specimen available (Jamaica, *Skinner & Robinson 7432)* but until more material is available and Reichenbach's type is better understood it is perhaps better not to try to separate the two.

The genus is new to Panama.

MAXILLARIA ARACHNITIFLORA A. & S.—COCLÉ: epiphytic; trail to Las Minas, hills north of El Valle de Antón, alt. 1000 m., Dec. 2, 1941, *Allen 2875.* Previously known from Costa Rica where it is rare. The present specimen is smaller than the type specimen.

MAXILLARIA **conduplicata** (A. & S.) L. O. Williams, comb. nov. *Ornithidium conduplicatum* A. & S., Sched. Orch. **8**: 66, *fig.* 1925).—CHIRIQUÍ: Palo Alto Hill, alt. 1300–1600 m., Sept.-Oct. 1923, *Powell 341.* Known only from Panama.

MAXILLARIA ENDRESII var. ANGUSTISEGMENTA (A. & S.) C. Schweinf. —COCLÉ: hills north of El Valle de Antón, alt. 1000 m., Dec. 2, 1941, *Allen 2870.*—Previously known from Costa Rica. The present specimen has blunter sepals and petals than usual and the peduncles are shorter.

MAXILLARIA **neglecta** (Schltr.) L. O. Williams, comb nov. *(Ornithidium anceps* Reichb. f., Beitr. Orch. Centr.-Am. 75. 1866, non *Maxillaria anceps* A. & S.; *O. neglectum* Schltr. in Fedde Repert. **19**:

242. 1923).—CANAL ZONE: on trees, hills north of Frijoles, Dec. 19, 1923, *Standley 27669;* CHIRIQUÍ: epiphyte in shade; valley of Upper Río Chiriquí Viejo, alt. 1300–1900 m., July-Aug. 1937, *White & White 37*. The species is quite a common one and extends from Honduras t' Panama.

MAXILLARIA **Pittieri** (Ames) L. O. Williams, comb. nov. *(Ornithidium Pittieri* Ames, Sched. Orch. **2**: 35. 1923).—CHIRIQUÍ: rain forest, Bajo Chorro, Boquete District, alt. ca. 2000 m., *Davidson 117*. Costa Rica and Panama.

CRYPTOCENTRUM CALCARATUM Schltr. in Fedde Repert. **12**: 214. 1913. *(Pittierella calcarata* Schltr. l.c. **3**: 81. 1906).—COCLÉ: region north of El Valle de Antón, alt. ca. 1000 m., (flowered at Ancon, C. Z.), Nov. 5, 1941, *Dunn 2762*. This is the third species of *Cryptocentrum* to be found in Panama recently. Previously known from Costa Rica where it is not uncommon.

TRICHOPILIA TURIALBAE Reichb. f.—VERAGUAS: epiphytic; mountains west of Azuero, alt. 600 m., (flowered in collection of Mr. A. G. B. Fairchild), Sept. 10, 1941, *Dunn s.n.*—Previously known from Costa Rica. *Trichopilia turialbae* is allied to *T. tortilis* Lindl. and seems to be distinguished by its smaller, differently colored flowers with lateral sepals connate to about the middle. The sepals and petals are 3 cm. long in our specimen, while the lip is 4 cm. long. The sepals and petals of the type of *T. turialbae,* of which we have a photograph, are nearly as long as the lip.

MESOSPINIDIUM WARSCEWICZII Reichb. f. in Bot. Zeit. **10**: 929. 1852; Xenia Orch. **1**: 36, *t. 16, figs. I, 1–11.* 1854.—COCLÉ: epiphyte; El Valle de Antón, alt. 650 m., (sepals and petals greenish yellow spotted maroon, lip pale yellow with minute red spots; flowered at San Francisco de la Calita), Aug. 30, 1941, *A. G. B. Fairchild (Allen 2685)*. Apparently the first collection of this species since the original was made some ninety years ago.

The determination has been made on the basis of the original description and figures I and 1 cited above. Figure 1 is exactly like the plant in hand, and figure I is fairly good; figures 4 and 5 are erroneous and misleading; the remainder of the figures are fairly good.

The generic status of the plant is open to some question. It is very close to *Odontoglossum* and especially to Lindley's group *"Myanthium,"* an aggregation of small-flowered species not unlike *Mesospinidium* in habit and flower structure. However, in *Mesospinidium Warscewiczii* there seems to be a short but distinct col-

umn foot and, consequently, a mentum. These conditions are not known to me to occur in *Odontoglossum*.

LOCKHARTIA MICRANTHA Lindl.—COCLÉ: region north of El Valle de Antón, alt. ca. 1000 m., Jan. 13, 1942, *Allen 1942*. This collection is peculiar because of the very short lateral lobes of the lip, in this case almost lacking. *Lockhartia integra* A. & S. is probably a synonym.

DICHAEA MORRISII Fawc. & Rendle.—COCLÉ: epiphytic; trail to Las Minas, hills north of El Valle de Antón, alt. ca. 1000 m., (sepals and petals striped with deep lavendar, lip deep lavendar), Dec. 2, 1941, *Allen 2874*. Previously known from the Costa Rica and the West Indies.

CHLORANTHACEAE

HEDYOSMUM NUTANS Sw.—BOCAS DEL TORO: Fish Creek Mts., Apr. 29, 1941, *H. von Wedel 2362*.—Known from the West Indies. Judging from the original description of *H. Brenesii* Standl. (Fl. Costa Rica, p. 371), that species may be synonymous with *H. nutans*. There seems to be no valid distinction between the von Wedel specimen and West Indian plants determined as *H. nutans*, and no justification in assuming a plant to be different from West Indian species merely because it is found on the Central American mainland.

LACISTEMACEAE

LOZANIA KLUGII Mansf.—BOCAS DEL TORO: Old Bank Island, Feb. 18, 1941, *H. von Wedel 2121*.—Previously known from Colombia and Peru. No specimens of *L. pedicellata* (Standl.) L. B. Smith were available for comparison, but in the von Wedel specimen the racemes are not always solitary in the leaf axils, the character separating *L. pedicellata* in Smith's key (Phytologia 1: 138. 1935) from the *L. Klugii* group. The specimen agrees well with South American specimens of *L. Klugii*. This genus has also been included in the Flacourtiaceae by many systematists.

MORACEAE

(P. C. Standley)

PEREBEA **hispidula** Standl., sp. nov.—Ramuli gracillimi brunnescentes vel ochracei dense hispiduli vel fere hirsuti, internodiis elongatis; stipulae caducae lineares ca. 1.5 cm. longae extus hirsutae; folia majuscula brevissime petiolata membranacea, petiolo crasso hirsuto vix ultra 4 mm. longo; lamina oblonga vel elliptico-oblonga

14–23 cm. longa 4.5–8 cm. lata caudato-acuminata, acumine angusto interdum fere lineari usque 2 cm. longo, basi paullo inaequali anguste rotundata vel obtusissima, remote saltem supra medium serrato-denticulata, supra sublucida ad costam sparse hirsuta aliter glabra, subtus paullo pallidior ad costam nervosque hispidula vel hirsuta ad venas puberula et in areolis minute scaberulo-asperata, costa tenui prominente, nervis lateralibus utroque latere ca. 16 angulo lato divergentibus leviter arcuatis prope marginem arcuato-conjunctis, venis prominulis laxe reticulatis; receptaculum femineum axillare fere sessile in statu fructifero 2 cm. latum, bracteis paucis imbricatis inaequalibus latis obtusis vel apiculatis, interioribus vix ultra 4 mm. longis, omnibus extus dense albido-strigosis; drupae ca. 8 sessiles ovali-globosae ca. 7 mm. longae et 5–6 mm. latae apice basique rotundatae, ubique dense hispidulae; stylus crassus cum ramis vix 1 mm. longus, ramis stylo brevioribus crassis acutis.—BOCAS DEL TORO: vicinity of Chiriquí Lagoon, *H. von Wedel 1935* (Herb. Missouri Bot. Gard. TYPE).

In leaves and inflorescence this tree, of somewhat doubtful generic position, is quite unlike any species of *Perebea* that has been recorded from Central America, and it is not very closely related to any of the South American ones of which material is available. Probably it is referred correctly to *Perebea*, but further material will be necessary to decide this point, the available specimens being unfortunately rather inadequate and incomplete.

CAPPARIDACEAE

CAPPARIS **clara** Schery, sp. nov. Arbuscula 5 m.; ramulis novellis aureobrunneis cum squamis minutis peltatis stellatis, internodiis ca. 2 cm. longis; foliis alternatis ellipticis basi acutis apice attenuatissime mucronatis, petiolis brevibus ca. 5 mm. longis angulatis supra anguste canaliculatis, laminis 15–20 cm. longis 4.3–6.3 cm. latis subtus argenteo-lucidis medio nervio prominente nervis lateralibus secondariis subprominentibus 7–12 paribus supra planis lepidotis glabris glaucescentibus; pedunculis ca. 10 cm. longis terminalibus vel subterminalibus in axilles foliorum aureo-brunneis squamis pilisque minutis stellatis, pedicellis ca. 6, ca. 2 cm. longis umbellatis; floribus albis gracilibus, calycibus patelliformibus extus argenteo-stellato-pubescentibus 4-lobatis lobis triangularibus 1 mm. longis, tubo 1 mm. alto; petalis oblongis ca. 8 mm. longis 3.5 mm. latis extus minutissime stellato-pubescentibus intus subglabris; staminibus ca. 20, filamentis glabris ca. 2 cm. longis, antheris

oblongis ca. 2 mm. longis, gynophorio glabro ca. 2.5 cm. longo; ovario pluriovulato oblongo 3 mm. longo stellato-pubescenti, stigmate sessili obtuso placentis 3 quisque cum 2 ordinibus ovularum; fructu ignoto.—BOCAS DEL TORO: Fish Creek Mts., Apr. 16, 1941, *H. von Wedel 2235* (Herb. Missouri Bot. Gard., TYPE).

Apparently this species is distinct from any published species known from Panama, Costa Rica, or Colombia. Its affinities are probably with *C. detonsa* Tr. & Pl., judging from the description of that species. In Dugand's clarifying synopsis of *Capparis* in Colombia (Caldasia **2**: 37. 1941), the von Wedel plant keys out to *C. detonsa,* but differs from it especially in having smaller flowers and a less pronounced pubescence. *C. clara* can be distinguished from most or all other species by the very long apical attenuation of the leaf. Characters also distinctive are the silvery sheen of the lower leaf surface, the slender, graceful inflorescence, and the minute golden-brown peltate scales of the very young branches. The leaves are perfectly elliptic, acute at the base, short-petiolate. The flowers are of medium size, 4-parted, umbelliform from an elongate peduncle. The elongate gynophore bears terminally an ovary with 3 placentae, each placenta with 2 rows of ovules. About 20 stamens surround the gynophore.

LEGUMINOSAE

COJOBA CATENATA (D. Sm.) Britton & Rose.—BOCAS DEL TORO: Isla Colón, July 29, 1940, *H. von Wedel 199.* Previously known from Costa Rica.

DITREMEXA LIGUSTRINA (L.) B. & R.—BOCAS DEL TORO: Isla Colón, Aug. 23, 1940, *H. von Wedel 517.* Apparently new to the continent; previously known from the West Indies.

INGA PREUSII Harms—BOCAS DEL TORO: Water Valley, Sept. 9, 1940, *H. von Wedel 672.* Previously known from northern Central America.

MELIACEAE

GUAREA CHICHON C. DC.—BOCAS DEL TORO: Cocoa Cay, vicinity of Chiriquí Lagoon, Oct. 26, 1941, *H. von Wedel 2874.* Previously known from Mexico and British Honduras.

MALPIGHIACEAE

HETEROPTERIS PLATYPTERA DC.—BOCAS DEL TORO: Old Bank Island, Feb. 8, 1941, *H. von Wedel 2027.* Previously known from South America.

DICHAPETALACEAE

DICHAPETALUM **axillare** Woodson, sp. nov. Arbuscula ca. 5 m. alta; ramulis novellis dense cinereo-tomentellis tandem glabratis. Folia brevissime petiolata oblongo-oblanceolata apice obtuse acuminata basim versus acute attenuata cum petiolo ca. 0.3 cm. longo 9–15 cm. longa 2.5–5.0 cm. lata firmiter membranacea venis venulisque utrinque cinereo-pilosulis petiolo simile. Inflorescentia aut terminalis aut axillaris numquam petiolo adnata subcapituliformis pauciflora ca. 1–2 cm. longa et lata dense cinereo-tomentella. Flores ca. 0.1 cm. longi pedicellati albi; sepalis ovatis ca. 0.2 cm. longis extus dense cinereo-pilosulis intus glabris; petalis aequilongis anguste ovatis medio bifidis; ovario ovoideo ca. 0.1 cm. longo dense pilosulo.—COCLÉ: hills north of El Valle de Antón, alt. about 1000 m., July 14, 1940, *P. H. Allen 2202* (Herb. Missouri Bot. Gard., TYPE).

Undoubtedly a close relative of *D. Donnell-Smithii* Engl., which has been reported as ranging from western Panama (probably Chiriquí) to British Honduras. This latter species, however, apparently always has more diffuse inflorescences with peduncles strongly adnate to the petiole of a subtending leaf, the leaves broader and less attenuate toward the base, and the indument less shaggy and conspicuously ferruginous.

DICHAPETALUM NEVERMANNIANUM Standl.—BOCAS DEL TORO: Water Valley, Oct. 30, 1940, *H. von Wedel 1424*. Previously known only from the type collection from Costa Rica.

EUPHORBIACEAE

(L. Croizat)

PERA **aperta** Croizat, sp. nov. Arbor 6-metralis; innovationibus plus minusve conferte crustaceo-lepidotis, indumento haud laeto; foliis more generis in sicco atro-discoloribus, supra costa excepta glabris, subtus lepidibus argillaceis dissitis adspersis, oblongis, apice breviter acuminatis, basi rotundato-cuneatis, 1.0–5 cm. longis, 2–4 cm. latis, margine revoluto subintegro, venis primariis plus minusve patentibus ca. 7-jugis, sat obscuris; petiolo eglanduloso, 1.5–2 cm. longo; inflorescentiis axillaribus, ♀ tantum visis; pedunculo communi gracili, lepidoto, ad 1 cm. longo, apice bracteolis binis ca. 2 mm. longis terminato, floribus ♀ pernudis, scilicet in sacco e bracteolis more generis efformato haud inclusis, glomerulatim 2–5, ecalyculatis vel subecalyculatis, ovario lageniformi, ca. 2.5 mm. longo, stylo in stigmatibus 3 latis, papillosis, obtriangularibus evadente;

loculis in ovario (videtur) 4, semine valde immaturo carunculato.—COCLÉ: hills south of El Valle de Antón, May, 1941, *P. H. Allen 2506*, (U. S. National Herb. TYPE).

The peculiar characters of the new species here described under Mutis's genus *Pera* suggest brief considerations of a preliminary nature on the limits of the genus.

The region in which the type material was collected is aptly characterized in a letter of P. H. Allen to C. V. Morton, quoted in the latter's work on the Gesneriaceae from Panama, and this writer readily agrees with Allen's comment: "I think I can guarantee that you will get some interesting plants" (Ann. Mo. Bot. Gard. **29**: 35. 1942). *Pera aperta,* indeed, is an extremely interesting plant, the first of its kind ever seen by this writer.

Aside from the technicalities of its flowers, *Pera* is supposed to be characterized by a peculiar involucre which surrounds the inflorescence. This involucre (see Pax & Hoffmann in Engler & Prantl's Nat. Pflanzenfam. **19c**: 154, *fig. 78 b,c,d,e.* 1931) is a bracteolate, bag-like structure which, towards anthesis, breaks open to expose the ♂ and ♀ flowers. The perianths proper are much reduced, and the entire arrangement may be defined as a coarctate lateral spicate or subglomerulate inflorescence, uni- or bisexual, surrounded by a bract or fused bracts which become open at the time of flowering. On account of the bracteate inflorescence, *Pera* has been maintained by Pax & Hoffmann as the type of the tribe Pereae, placed next to the Dalechampieae in the classification of Engler & Prantl, a disposition which is probably more artificial than natural but is not to be challenged here.

Pera is the subject of an unusually large literature which deals with its sectional or presumedly sectional units. In one of the early studies of this group, Klotzsch (in Wiegm. Arch. **7**: 176. 1841) published the tribe Prosopidoclineae, typified by *Pera* and characterized by: "Ovarii loculi uniovulati. Semina arillata, exalbuminosa. Involucra subgloboso-vesicaeformia, hinc hiantia, deinde plus minusve explanata, demum decidua, 3,4–6 flora, bracteis suffulta. Flores dioeci, apetali." Regarding Klotzsch's later publication of the Peraceae as a family, this writer may remark that Prosopidoclineae is an illegitimate tribal name, because it is not derived from the name of a genus under the group (Art. 24, Internat. Rules Bot. Nomencl., 1935). Non-existent as a taxonomic name under the Rules (Art. 7) are Baillon's "Péridées" (Étude Gén. Euphorb., 433. 1858), improperly cited by Pax & Hoffmann (in op. cit., 153) as

Perideae. The legitimate tribal[1] name for the *Pera* plexus, consequently, remains Mueller's Pereae (Linnaea **34**: 144. 1865).

Klotzsch recognized under the Prosopidoclineae: *Schismatopera* Kl., *Spixia* Leandro do Sacr., *Pera* Mutis, and *Peridium* Schott. This arrangement was criticized by Baillon (op. cit., 268-272), who maintained as a genus only *Pera* with two sections (op. cit., 433-434), Eupera and Schismatopera, characterized, respectively, by "Étamines au nombre de 2–6 (ou plus), unies inférieurement dans une étendue peu considérable," and "Étamines 4–8 monadelphes; filets soudés en une colonne cylindrique plus longue." This separation rests upon an essential difference apparent in many euphorbiaceous flowers, some of which have the androecium connate to form a staminal column (*Jatropha,* for instance); others, on the contrary, have solute stamens (*Manihot* being an example). Whether this difference holds good in *Pera,* as claimed by Baillon, this writer does not know; its basis is sound in theory, but it may be found in practice that the much reduced perianths of *Pera* bear both androecia set up into columns or more or less solute, within the same natural affinity.

In his elaboration of the Euphorbiaceae (in DC. Prodr. **15**^{2}: 1025-1031. 1866), Mueller maintains five sections, Schismatopera (Kl.) Baill., Eupera Baill., Spixia (Leandro do Sacr.) Baill., Neopera Griseb., Peridium (Schott) Muell.-Arg. Another section, Diplopera, is added by Mueller in Martius, 'Flora Brasiliensis' (**11**^{2}: 423. 1874), which Mueller describes as follows: "Involucra basi unibracteolata, bisexualia, simul flores masculos 3–4 centrales et femineos periphericos gerentia. Calyx masc. evolutus . . . Sectio insigniter peculiaris. . . ." Six sections, too, are maintained in the most recent classification of Pax & Hoffmann (op. cit., 154), as follows: Diplopera Muell.-Arg., Perula (Schreb.) Pax & Hoffmann, Spixia (Lean-

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[1] The proper definition and correct consequent use in modern taxonomy of the units between the genus and the family, and the genus and the species, published by early or comparatively early authors, is beset with difficulties on account of the loose and conflicting manner in which these authors were wont to interpret or define these units. For instance: Mueller published the Pereae, but designated and consequently used them as a subtribe, not as a tribe. Since Art. 24 of the current Rules declares that the name of a tribe ends in -eae and that of a subtribe in -inae, there is conflict between Mueller's name and his own designation of it. This writer believes that, *in principle,* such conflicts are to be defined in the sense that the designation of the rank by the author of the name is irrelevant, under Art. 24, so long as it is contradicted by the name's ending. Thus, the Pereae of Mueller, having the legitimate ending of a tribal name, are to be accepted in modern taxonomy *as a tribe,* despite Mueller's insistence that *they are a subtribe.* This principle is general and important enough to deserve special mention here.

dro do Sacr.) Muell.-Arg., Schismatopera (Kl.) Baill., Neopera Griseb., Peridium (Schott) Muell.-Arg. This classification, which does not differ from that of Mueller in essential characters, is erroneous in two respects: (1) It substitutes Perula Pax & Hoffm. for Eupera Baill., under the evidently mistaken assumption that Schreber's Perula, being earlier than Eupera Baill., must be used as the basis for a new combination. Pax & Hoffmann probably are not aware of the fact that new combinations are required (Art. 53) only when names are transferred *without a change of rank*, it being illegitimate to effect a transfer, *when the rank is changed* and the position is preoccupied (Art. 16, Art. 61 [1]).[1] (2) It mistakenly credits the combination of Spixia to Mueller, while this combination was effected by Baillon (in Adansonia 5: 222. 1864-1865).

Under the systematic viewpoint, none of the current subgeneric units of *Pera* even approach the characters of *P. aperta,* for in this peculiar plant the involucre is absent, or at least reduced to minute bracteoles at the base of the gynoecium. In view of the emphasis placed throughout classification upon the involucre as a generic character it should be possible to elect *P. aperta* as the type of a new genus. This writer does not believe that the erection of a new genus is advisable, at least until much better material is available, because: (1) The Euphorbiaceae are identified by a tendency towards reduction and recombination of the floral organs rather than by set morphological characters. Accordingly, tendencies count in their classification far more than do characters; (2) The wood characters of *P. aperta* are those of Mutis's genus, as this writer has kindly been informed by Prof. I. W. Bailey of the Biological Laboratories of Harvard University, and so its gross morphology is that of *Pera.* (3) It is not to be overlooked that certain species in the vicinity of *P. aperta* may have partially developed involucres, intermediate between those of this species and the ones of *P. arborea* and its immediate allies. In conclusion, the emphasis placed upon the involucre as a generic character of *Pera* is not completely justified, and rather than a new genus, an emended description of *Pera,* the Pereae, and two new subgenera are required, as follows:

PERA Mutis in Svensk. Vetensk. Akad. Handl. Stockholm 5: 299. 1784; Muell.-Arg. in DC. Prodr. 15^2: 1025. 1866, et in Mart. Fl. Bras.

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[1] On account of a faulty interpretation of Art. 58, some botanists believe that older names must be maintained even when the rank is changed. This fallacy is refuted in a paper on the trinomial *typicus,* by this writer, now in course of publication.

11^2: 421. 1874; Pax & Hoffmann in Engler & Prantl's Nat. Pflanzenfam. **19c**: 153. 1931; *Croiz. descr. emend.*

Flores utriusque sexus in involucro alabastriformi inclusi (subg. Eupera), involucro saltem ♀ interdum (subg. Gymnopera) nullo vel subnullo.

This emendation modifies also the characters of the Tribe Pereae, which is essentially based upon *Pera,* as follows:

Pereae Muell.-Arg. in Linnaea **34**: 144. 1865, et in DC. Prodr. 15^2: 1025. 1866; Pax & Hoffmann in Engler & Prantl's Nat. Pflanzenfam. **19c**: 153. 1931; *Croiz. descr. emend.*

Flores utriusque sexus saepissime in involucro alabastriformi inclusi.

Pera subg. **Eupera** (Baill.) Croiz., st. nov. *(Pera* Sect. *Eupera* Baill. in Étude Gén. Euphorb., 434. 1858, p.p.typ.; *Pera* Sect. *Perula* [*nomen serius illegitimum*] Pax & Hoffm. in Engler & Prantl's Nat. Pflanzenfam. **19c**: 154. 1931).

Floribus utriusque sexus in involucris alabastriformibus inclusis.

Typus nomenclaturalis: *Pera arborea* Mutis.

This writer does not know whether all the sections of Mueller and Pax & Hoffmann properly belong to a single subgenus, although he accepts as most probable at this writing that a separation can be established between *Pera* ssp. in general and *P. aperta* on the strength of the involucre character. In Martius', 'Flora Brasiliensis' (op. cit., 11^2: 421. 1874) Mueller accepts *Pera* "sensu Baill.," a disposition which this writer is neither prepared to challenge nor to endorse without qualification at this time.

Pera subg. **Gymnopera** Croizat.

Floribus saltem ♀ involucro alabastriformi carentibus, ad bracteolas minimas reducto.

Typus nomenclaturalis: *Pera aperta* Croizat.

HIPPOCRATEACEAE

Hippocratea celastroides HBK.—bocas del toro: Old Bank Island, Feb. 8, 1941, *H. von Wedel 2038.* Known from northern Central America and recorded from Colombia. Specific delimitation in this genus is at present so uncertain that it cannot be stated with surety that the von Wedel specimen is correctly determined. However, it matches other specimens so labeled in the herbarium, and seems distinct from *H. volubilis* L. growing in the same locality.

Hippocratea ovata Lam.—bocas del toro: vicinity of Chiriquí Lagoon, Oct. 7, 1940, *H. von Wedel 1059.* Known from South

America. This Wedel specimen in fruit may prove to be the same as *H. volubilis* or *H. celastroides,* but best matches specimens in the Missouri Botanical Garden herbarium labeled *H. ovata.*

ICACINACEAE

(R. A. Howard)

DISCOPHORA MONTANA Howard—BOCAS DEL TORO: Fish Creek Mts., Apr. 14, 1941, *H. von Wedel 2225.* Previously known only from Colombia.

SAPINDACEAE

CUPANIA HIRSUTA Radlk.—PANAMÁ: Vicinity of Capira, Feb. 12, 1939, *P. H. Allen 1687.* Previously known from South America. No satisfactory separation seems possible between this species and specimens in the herbarium labeled *C. fulvida.* The Allen specimen is intermediate between South American forms represented in the herbarium as *C. hirsuta,* and Costa Rican forms represented by specimens determined as *C. fulvida* Tr. & Pl.

PAULLINIA CALOPTERA Radlk.—BOCAS DEL TORO: Water Valley, Sept. 23, 1940, *H. von Wedel 904.* Previously known from South America.

QUIINACEAE

(P. C. Standley)

LACUNARIA **panamensis** (Standl.) Standl., comb nov. (*Quiina panamensis* Standl. Field Mus. Publ. Bot. 4: 236. 1929).—COCLÉ: hills north of El Valle de Antón, trail to La Mesa, alt. about 1000 m., Aug. 31, 1941, *P. H. Allen 2689.* A tree 15 m. tall; fruits woody, brown. *Quiina panamensis* was based upon *G. Proctor Cooper 609,* from Buena Vista Camp on Chiriquí trail, Prov. Bocas del Toro, and consisted of specimens in bud. Study of the type and of the recent collection obtained by Mr. Allen shows that the tree belongs to the genus *Lacunaria,* segregated in 1925 from *Quiina* by Dr. Ducke. Rather numerous *Quiina* species of South America have been transferred to *Lacunaria* in recent years, and it is not surprising to find a member of the genus in Panama. The only other member of the family known from North America, *Quiina Schippii* Standl. of British Honduras, is properly referable to *Quiina.*

Mr. Allen's material includes a mature fruit, which may be described as follows: Fruit depressed-globose, in shape resembling that of *Hura crepitans,* about 8 cm. broad and 5.5 cm. high, slightly depressed at the apex, densely costate vertically with low rounded

ribs, filled with pulp, the pericarp hard and woody, 3 mm. thick; seeds about 1 cm. long, very densely covered with long brown hairs.

TILIACEAE

(P. C. Standley)

MORTONIODENDRON **hirsutum** Standl., sp. nov.—Frutex metralis, ramis gracilibus ochraceis teretibus, novellis pallide viridibus sat dense pilis longis patentibus fulvis hirsutis; folia breviter petiolata membranacea, petiolo crassiusculo 4–5 mm. longo hirsuto; lamina anguste oblonga vel lanceolato-oblonga 10.5–17 cm. longa 3–4.5 cm. lata, apice longissime lineari-attenuata, basi insigniter obliqua, latere interiore acuta, exteriore late rotundata vel subcordata, supra in sicco viridis ad costam sparse hirsuta, aliter glabra, venis prominulis laxe reticulatis, subtus fere concolor ad costam nervosque hirsuta, costa tenui elevata, nervis lateralibus utroque latere 8–9 tenerrimis arcuatis, venis prominulis laxe reticulatis, basi trinervia; inflorescentia (tantum in statu fructifero visa) terminalis longipedunculata ut videtur pauciflora, rhachi hirsuta, pedicellis fructiferis ca. 12 mm. longis crassiusculis; capsula depresso-globosa lutea ca. 2 cm. alta atque 2.5 cm. lata valde rugosa, valvis crassis ca. 12 mm. latis; semina in quoque loculo 2 crassa obtuse angulata 6 mm. diam. —BOCAS DEL TORO: Water Valley, vicinity of Chiriquí Lagoon, Nov. 21, 1940, *H. von Wedel 1694* (Herb. Missouri Bot. Gard. TYPE).

The genus *Mortoniodendron* Standl. & Steyerm., published in 1938 and based upon a Panama plant, has grown surprisingly in species numbers during the past few years. In 1940 two species were described from Honduras and Guatemala, the present being the fourth known representative of the genus. *M. hirsutum* may be recognized at once as distinct from the other Panama species, *M. anisophyllum* (Standl.) Standl. & Steyerm., by its fairly abundant pubescence of long, stiff, straight spreading hairs, a character which distinguishes it also from the more northern species.

BOMBACACEAE

CEIBA **Allenii** Woodson, sp. nov. Arbor epiphytica ramosissima ut dicitur ca. 10–12 m. alta; ramulis crassiusculis rimosis sparse aculeolatis. Folia desunt. Flores solitarii vel bini magni speciosi; pedicellis crassiusculis ca. 2 cm. longis; calyce late urceolato ca. 2 cm. longo ostio ca. 1.5 cm. diam. obscure irregulariterque 2- vel 5-lobato coriaceo glabro vel indistincte papillato; petalis 5 oblongis rotundatis minute emarginatis 5–6 cm. longis ca. 1.5 cm. latis carnosis

patulis extus papillatis marginibus densius saturate roseis intus lacteis; staminibus 5, filamentis 3.5–4.0 cm. longis ca. ½ longitudine connatis, antheris linearibus dorsifixis ca. 3.5 cm. longis basi bifidis. —COCLÉ: hills north of El Valle de Antón, alt. about 1000 m., May 10, 1942, *P. H. Allen 2924* (Herb. Missouri Bot. Gard. TYPE).

Ceiba Allenii falls readily into Schumann's section Eriodendron, previously represented by two species of central Brazil. From our species *C. Rivieri* (Dcne.) K. Sch. differs because of its shorter, truncate calyx, and *C. Erianthos* K. Sch. because of its more slender habit and much smaller flowers. It is very unfortunate that the plant bloomed in a leafless condition. Mr. Allen describes it as a "strangler tree" similar to species of *Ficus*.

STERCULIACEAE

THEOBROMA **asclepiadiflorum** Schery n. sp. Arbor ut dicitur 30 m. alta; ramis glabris brunneis; foliis magnis 30–40 cm. longis 10–13 cm. latis ellipticis utrinque omnino glabris apice cuspidatis basi acutis in petiolis subdecurrentibus subtus costa 1 prominentissima nervis lateralibus 24–34 arcuatis prominentibus; petiolis ca. 1.5 cm. longis supra subcanaliculatis; inflorescentiis cymiformibus, pedunculis brunneis stellato-tomentosis 3–4-pli-divisis in multos pedicellos cum bracteis parvis ad locos divisionum; floribus coccineis magnis; sepalis anguste ovato-lanceolatis ca. 12 mm. longis 3–4 mm. latis crassis reflexis extus stellato-tomentosis intus glabris margine puberulentis basi pilis crassis glandulosis luteis; petalis obovatis cochleatis 6 mm. longis 4 mm. latis interne glabris externe apice pubescentibus cum ligulis rotundatis lepidotis; staminibus et staminodiis basi cohaerentibus in tubum glabrum 2 mm. altum, filamentis glabris 3 mm. longis cum 2 antheris bilocularibus, staminodiis anguste lanceolatis 10 mm. longis basi 2 mm. latis puberulentis; ovario ellipsoideo tomentoso 5-lobato cum stylo 5-partito; fructibus ignotis.—BOCAS DEL TORO: Water Valley, Nov. 8, 1940, *H. von Wedel 1535* (Herb. Missouri Bot. Gard. TYPE).

Although fruiting material of this species is lacking, floral and vegetative characters distinguish it sufficiently to warrant description as a new species. As in *T. Cacao* the branchlets and leaves are entirely glabrous, a character which separates it from the typical *T. bicolor*. The elliptic leaves are not asymmetric at the base and are subdecurrent on the petiole. The inflorescence is a many-flowered cyme about 5 cm. long, branching 3 or 4 times in a di- or trichotomous fashion. The large red flowers, with their reflexed sepals,

cochleate petals resembling hoods and long narrow staminodes resembling horns, superficially simulate asclepiadaceous flowers. The ligules of the petals are more or less sessile, not clawed as in *T. Cacao.* The long thin staminodes appear tentacular, not foliaceous as in *T. simiarum.* The form of the ovary suggests that the fruit is shallowly 5-lobed.

DILLENIACEAE

(C. V. Morton)

SAURAUJA PAUCISERRATA Hemsl.—COCLÉ: trail to Las Minas, north of El Valle de Antón, alt. 1000 m., May 10, 1941, *Paul H. Allen 2464.* This species was described from the Volcán de Fuego, Guatemala. The present specimen agrees with the description and with a photograph of the type. Several specimens from Guatemala and El Salvador have been referred to this species, some of which may be incorrectly identified. The recently described *S. Seibertii* Standl., which also has glabrous leaves, differs (from description) in its larger sepals and petals, longer inflorescence and pedicels, and larger, many-veined, more strongly serrate leaves.

OCHNACEAE

SAUVAGESIA ELATA Benth.—BOCAS DEL TORO: Old Bank Island, Feb. 8, 1941, *H. von Wedel 2029.* Previously known from South America.

MARCGRAVIACEAE

MARCGRAVIA NEPENTHOIDES Seem.—BOCAS DEL TORO: Water Valley, Sept. 17, 1940, *H. von Wedel 818;* Chiriquí Lagoon, Oct. 15, 1940, *H. von Wedel 1192.* Previously known from northern Central America, possibly reported from Costa Rica. The von Wedel specimens check well with published illustrations of this species, although differing somewhat from the only specimen in the herbarium under this name.

NORANTEA ALBIDO-ROSEA Gilg, ex char.—BOCAS DEL TORO: Old Bank Island, Feb. 8, 1941, *H. von Wedel 2035.* Known from Costa Rica. This specimen may well prove to be the same as *N. Brenesii* Standl., also known from Costa Rica, corresponding within the limits of variability with specimens of the latter in the herbarium. However the original description of *N. Brenesii* does not fit the von Wedel specimen as accurately as that of *N. albido-rosea.* The plant can be distinguished from *N. subsessilis* (Benth.) D.Sm. by its subumbelliform inflorescence.

GUTTIFERAE

CLUSIA **longipetiolata** Schery, n.sp. Arbuscula circ. 30 m. alta; ramis glabris irregulariter nodulatis internodiis 0.5–1.5 cm. longis; foliis magnis longe-petiolatis glabris crassis coriaceis; laminis ellipticis vel obovato-oblongis basi cuneatis apice rotundatis margine leviter subrevolutis, nervis lateralibus multis (60-90) circ. 80° a nervo medio divergentibus utrinque prominentibus; petiolis 4.5–8.0 cm. longis crassis in sicco longitudinaliter striatis subteretibus vel angulatis sed non alatis basi lacunis semicrateriformibus; inflorescentiis terminalibus cymiformibus 2–3-floris; pedicellis principalibus 0.5–1.0 cm. longis apice cum bracteis 2 deltoideis oppositis; pedicellis secondariis subteretibus crassis 1–2 cm. longis item apice cum 2 bracteis deltoideis oppositis; floribus flavo-albis magnis circ. 5–6 cm. latis; 2 lobis calycis exterioribus basi concretis patelliformibus fulgidis, 5 aliis lobis late ovato-rotundatis coriaceis; petalis submembranaceis ovato-rotundatis, circ. 2.5 cm. longis, 3 cm. latis; toro cylindrico 6–7 mm. alto ovarium circumdante; ovario 5-carpellato pyramidali stigmati sessili; flores masculae ignotae.—BOCAS DEL TORO: vicinity of Chiriquí Lagoon, alt. near sea-level, Oct. 12, 1940, *H. von Wedel 1136* (Herb. Missouri Bot. Gard. TYPE).

This species is distinguishable especially by its large cream-colored flowers, very long unwinged petioles, and thick coriaceous leaves. The torus (fused staminodia of Vesque) is cylindric-campanulate, completely surrounding the 5-carpellate ovary to a height of 6 or 7 mm. The relationship of this species is probably with *C. rosea, C. Cooperi, C. stenophylla,* etc., from the same general region. Although belonging to a genus in which "probable new species" of distinctive appearance are continually turning up, this von Wedel specimen could not be satisfactorily matched in the herbarium, nor in Vesque's monograph nor with recent descriptions.

VIOLACEAE

(C. V. Morton)

IONIDIUM THIEMEI Donn. Smith—COCLÉ: north rim of El Valle de Antón, June 4, 1939, *Alston & Allen 1859.* This collection was distributed as *Hybanthus parietariifolius* (DC.) Loes., a synonym of the annual species, *H. attenuatus* (H. & B.) G. K. Schulze. *Ionidium Thiemei* (previously known from Mexico to Honduras) is a perennial, and differs in many ways from *H. attenuatus.* It is to be referred to the genus *Hybanthus* also, of course, but I refrain from

making a combination at the present time, inasmuch as I am preparing a paper to be published elsewhere on the North American species of this genus.

FLACOURTIACEAE

LUNANIA PITTIERI Standl.—BOCAS DEL TORO: Fish Creek, mountains, May 7, 1941, *H. von Wedel 2396*. Previously known only from the type collection from Costa Rica.

TURNERACEAE

(C. V. Morton)

ERBLICHIA ODORATA Seem.—COCLÉ: trail to Las Minas, north of El Valle de Antón, alt. 1000 m., May 10, 1941, *Paul H. Allen 2468*. This genus was long considered monotypic, but in a recent revision Standley and Steyermark (Field Mus. Publ. Bot. **22**: 351–357. 1940) have recognized three species and one variety. According to their treatment, the present specimen woud key at once to *E. Standleyi* Steyerm. of Oaxaca and Honduras. However, both Standley and Steyermark have studied Allen's specimen and are inclined to place it with *E. odorata,* the type species of the genus, which was originally collected in Panama but has not since been found there, although it is rather common in Costa Rica. Allen's collection throws some doubt on the validity of *E. Standleyi* as a species, since it differs from typical *E. odorata* in the same characters (glabrous ovary and branchlets) as *E. Standleyi* does from *E. xylocarpa.*

CARICACEAE

CARICA DOLICHAULA D. Sm.—BOCAS DEL TORO: Chiriquí Lagoon, Oct. 8, 1940, *H. von Wedel 1084*. Previously known from Costa Rica and ranging to British Honduras.

CACTACEAE

(L. Cutak)

EPIPHYLLUM MACROPTERUM (Lemaire) Britton & Rose—BOCAS DEL TORO: Water Valley, Sept. 12, 1940, *H. von Wedel 736;* vicinity of Chiriquí Lagoon, Oct. 16, 1940, *H. von Wedel 1164*. Previously known from Costa Rica.

EPIPHYLLUM PITTIERI (Weber) Britton & Rose—BOCAS DEL TORO: vicinity of Chiriquí Lagoon, Oct. 21, 1940, *H. von Wedel 1294*. Previously known from Costa Rica.

THYMELIACEAE

SCHOENOBIBLUS PANAMENSIS Standl.—BOCAS DEL TOTO: Isla Colón?, *H. von Wedel 410*, Aug. 12, 1940. This is apparently the first record of the genus for North America. Species have previously been known from South America and the West Indies.

ONAGRACEAE

JUSSIAEA LATIFOLIA Benth.—BOCAS DEL TORO: Water Valley, *H. von Wedel 781*, Sept. 14, 1940; Chiriquí Lagoon, *H. von Wedel 1384*, Oct. 18, 1940. Previously known from South America.

LOGANIACEAE

POTALIA AMARA Aubl.—BOCAS DEL TORO: Fish Creek Mts., Apr. 30, 1941, *H. von Wedel 2369*. Previously reported from Costa Rica and South America. Although to be expected from Panama, this collection is of interest in that it apparently is only the third or fourth for the genus from North America. The ovary of the von Wedel plant is four-carpellate in contrast to the two-celled condition reported by Standley (Fl. Costa Rica, p. 921. 1938) and the three-celled condition reported by Aublet (Pl. Gui. **1**: 394. *pl. 151.* 1775) in the original description for the species.

APOCYNACEAE

STEMMADENIA **lagunae** Woodson, sp. nov. Arbor vel arbuscula ca. 5–12 m. alta omnino glabra; ramulis dichotomis gracillimis, internodiis ca. 1.0–2.5 cm. longis. Folia opposita inaequalia breviuscule petiolata elliptica apice abrupte subcaudato-acuminata basi in petiolum attenuata 4.5–14.0 cm. longa 1.5–5.0 cm. lata; petiolis 0.3–0.8 cm. longis. Inflorescentiae terminales vel subterminales bostrycino-racemosae pauci- vel pluriflorae; pedunculo simplici vel basi dichotomo 1.0–2.5 cm. longo omnino minute bracteato cicatricosoque; pedicellis ca. 0.5 cm. longis. Calycis laciniae oblongae vel oblongo-oblanceolatae acutae vel obtusae valde inaequalia 1–2 cm. longae subfoliaceae. Corolla pallide aurea infundibuliformis tubo proprio 2.5–3.0 cm. longo basi ca. 0.2–0.3 cm. diam. superne contorto angustioreque ibique staminigero faucibus conicis abrupte dilatatis 1.0–1.25 cm. longis ostio ca. 0.5–0.7 cm. diam. lobis oblique obovatis acuminatis 1.5–2.0 cm. longis patulis. Folliculi ignoti.—BOCAS DEL TORO: Careening Cay, July-Aug., 1940, *H. von Wedel 570* (Herb. Missouri Bot. Gard., TYPE); Water Valley, Sept. 6, 1940, *H. von Wedel 587* (Herb. Missouri Bot. Gard., COTYPE).

This species of the *S. Alfari* complex is interesting because of its occurrence near the coast of the Chiriquí Lagoon, the other species inhabiting higher altitudes. It apparently is most closely allied to *S. Allenii* Woods., which has much shorter calyx lobes (0.6–0.9 cm.) and corollas of different proportions and size (proper tube 1.0–1.25 cm. long; throat about 2 cm. long).

PRESTONIA **Wedelii** Woodson, sp. nov. Frutex volubilis; ramulis dense ferrugineo-tomentosis. Folia brevissime petiolata ovato-elliptica apice acuminata basi obscure cordata 13–16 cm. longa 6–10 cm. lata utrinque subtus densius minute ferrugineo-tomentella, petiolo 0.2–0.5 cm. longo tomentoso. Inflorescentia dense bostrycino-racemosa multiflora; pedunculo 2–15 cm. longo ferrugineo-tomentoso, pedicellis 0.5–0.7 cm. longis similiter vestitis; bracteis anguste lanceolatis ca. 1 cm. longis foliaceis pilosis. Calycis laciniae oblongo-lanceolatae longe acuminatae 3.0–3.5 cm. longae foliaceae pilosae; squamellis deltoideis apice emarginatis vel laceratis sparse pilosulis. Corolla luteo-lactea extus dense ferrugineo-tomentella tubo infundibuliformi ca. 4 cm. longo basi ca. 0.2 cm. diametro tertia parte superiore staminigera ibique conico-dilatata ostio ca. 0.7–0.8 cm. diametro, lobis oblique ovatis acuminatis ca. 1.2 cm. longis patulis; annulo faucali bene manifesto ca. 0.1 cm. lato continuo haud lobato. Ovarium glabrum ca. 0.2 cm. altum; nectario conico-annulato ostio 5-lobato glabro ovarium paulo superante.—BOCAS DEL TORO: Water Valley, vicinity of Chiriquí Lagoon, Oct. 26, 1940, *H. von Wedel 1353* (Herb. Missouri Bot. Gard., TYPE).

Superficially similar to *P. Allenii,* but with shorter pubescence and obscurely cordate leaves. The flowers of *P. Allenii,* also, are larger, and the faucal annulus of the corolla consists of 5 discrete, round lobes.

BONAFOUSIA SANANHO (R. & P.) Mgf.—COCLÉ: vicinity of La Mesa, region of El Valle de Antón, alt. ca. 1000 m., Nov. 12, 1941, *P. H. Allen 2804.* Previously known from western Colombia (Bogotá), eastern Ecuador, eastern Peru, and western Brazil. This discovery is of particular interest since it represents an element of *Tabernaemontana* previously thought to be entirely South American. Other South American species have been collected by Mr. Allen in the region of El Valle, and this element probably is considerable in its flora.

ASCLEPIADACEAE

SARCOSTEMMA ODORATA Hemsl.—BOCAS DEL TORO: Water Valley, Nov. 23, 1940, *H. von Wedel 1755.* Previously collected in Guatemala

and Costa Rica. Our plants differ somewhat from those of Guatemala in being practically glabrous.

GONOLOBUS **Ophioglossa** Woodson, sp. nov. Frutex volubilis; ramulis gracilibus laxe pilosulis. Folia opposita longiuscule petiolata heterophylla oblongo- vel obovato-ovalia apice acuminata basi aut obtusa aut obscure sagittata aut profunde cordato-sagittata 4–10 cm. longa 1.5–4.5 cm. lata membranacea glabra; petiolo 1–2 cm. longo minute pilosulo. Inflorescentia extra-axillaris subumbellata pluriflora; pedunculo 0.3–0.7 cm. longo glabro; pedicellis tenuibus ca. 2 cm. longis glabris; bracteis minimis. Flores virides; calycis laciniis ovato-lanceolatis acuminatis ca. 0.3 cm. longis glabris; corolla rotata ca. 3 cm. diam. omnino glabra, lobis late ellipticis ca. 1.5 cm. longis margine albo; corona acute 5-gona plana laevi corollae annulum carnosum minute puberulo-papillatum aequante; gynostegio stipitato acute 5-gono ca. 0.35 cm. diam., antherae appendicibus dorsalibus anguste ligularibus ca. 0.2 cm. longis apice furcatis patulis.—COCLÉ: vicinity of La Mesa, north of El Valle de Antón, alt. about 1000 m., April 12, 1941, *P. H. Allen 2366* (Herb. Missouri Bot. Gard., TYPE).

This species of the subgenus Eugonolobus is outstanding not only because of the ligular, forked anther appendages which suggest its name, but also because of the variable leaves.

BORAGINACEAE

BOURRERIA SUPERBA Johnston var. **glabra** Schery, var. nov. Ab specie differt foliis utrinque glabris et calycibus glabris loborum marginibus intus tomentosis exceptis.—BOCAS DEL TORO: Isla Colón, June 3, 1941, *H. von Wedel 2472.* This variety resembles the species except that the lower leaf surface and the inside of the calyx tube are entirely glabrous. The margins of the calyx lobes, however, are white-tomentose on the inside. The large size of the flowers (about 4 cm. long, 4 cm. wide) distinguishes this species from other species previously known from the region. *B. superba* is known from Mexico (Michoacan).

SOLANACEAE

CAPSICUM STANDLEYANUM Morton—BOCAS DEL TORO: vicinity of Chiriquí Lagoon, Oct. 23, 1940, *H. von Wedel 1316.* Previously known from Costa Rica. This species as represented by the von Wedel specimens may not be distinct from *C. stenophyllum* Morton & Standley. The leaves are strongly dimorphic, resembling those of *Solanum diphyllum.*

BIGNONIACEAE

SCHLEGELIA **fastigiata** Schery, sp. nov. Frutex scandenti-epiphyticus; ramulis teretibus brunneis rugosis parvis cum lenticellis prominentibus ovalibus albis; foliis magnis glabris coriaceis ellipticis apice acutis basi rotundatis vel acutis in petiolo decurrentibus, nervis reticulatis supra aliquid impressis inconspicuis subtus prominentibus nervis lateralibus arcuatis ad margines, aliquid confluentibus, 12–25 cm. longis, 4–10 cm. latis; petiolis crassis, supra subcanaliculatis, ca. 1 cm. longis, 3–4 mm. latis; inflorescentiis terminalibus vel subterminalibus crassis condensatis fastigiatis sessilibus, 2–7 cm. longis, 5–10 cm. latis, plurimis subcorymbiformibus racemis compositis; pedicellis 4–8 mm. longis, 0.5–1.0 mm. latis; calycibus plus minusve 4-lobatis vel subtruncatis cylindrico-campanulatis reticulàto-subrugosis glabris, 7–10 mm. longis; corolla glabra, 1.0–2.5 cm. longa, 5-lobata, lobis ca. 2.5 mm. longis, ovato-triangularibus subhastatis imbricatis, tubo plus minusve cylindrico, ca. 8 mm. longo; staminibus 4, ca. 5 mm. longis, ⅓ longitudine tubi adjunctis; staminodio 1; filamentis glabris aequalibus linearibus basi latioribus; antheris bilocularibus, loculis longitudinaliter dehiscentibus basi divergentibus; stylo crasso, ca. 2 mm. longo apice aliquid bifidi; ovario sessili biloculari pluriovulato basi crasso-carnoso; fructibus globularibus purpureis lepidotis, circiter 14 mm. diametro.—BOCAS DEL TORO: Water Valley, Sept. 14, 1940, *H. von Wedel 773* (Herb. Missouri Bot. Gard., TYPE); Isla Colón, July 26, 1940, *H. von Wedel 154* (Herb. Missouri Bot. Gard., COTYPE); Water Valley, Oct. 31, 1940, *H. von Wedel 1447* (Herb. Missouri Bot. Gard., COTYPE).

This species seems to be most closely allied to *S. lawrancei* Standl. and *S. dariensis* Sandw. (ex char.). Like *S. dariensis* it seems to be intermediate between short, lateral inflorescence types (sect. Parantanaecium K. Schum.) and long terminal inflorescence types (sect. Euschlegelia K. Schum.). The species differs from *S. lawrancei* chiefly in having a very characteristic inflorescence and more narrowly elliptic leaves, and from *S. dariensis* (ex char.) especially in having elliptic rather than broadly ovate, more or less cordate leaves.

The most striking and characteristic feature of this species is the dense fastigiate inflorescence which resembles "witches broom." The many pedicels and peduncles are so congested that it would be impossible for each to bear a flower simultaneously. Leaves are elliptic, short-petiolate, acute to rounded at the base and somewhat

decurrent into the petiole, acute apically. The flowers are reported as red (calyx) and white (corolla). The calyx is subtruncate or shallowly 4-lobed, glabrous within and without. The corolla is glabrous, small, 1.0–2.5 cm. long, 5-lobed, the lobes being imbricate, ovate-triangular, subhastate. The tube is about 8 mm. long and bears at about 3 mm. from the base 4 stamens and one staminode. The filaments are glabrous, linear, slightly broader at the base than above. The anthers are bilocular, the locules dehiscing longitudinally and diverging from one another basally. The style is stigmatose and slightly bifid apically. The ovary is 2-celled, many ovules being borne in each cell from a central placenta.

ARRABIDAEA CHICA (H. & B.) Verl.—BOCAS DEL TORO: Water Valley, Sept. 19, 1940, *H. von Wedel 860.* Previously known from British Honduras and Guatemala, possibly other countries.

LENTIBULARIACEAE

(C. V. Morton)

UTRICULARIA ENDRESII Rchb. f.—COCLÉ: hills north of El Valle de Antón, alt. 1000 m., Sept. 1, 1941, *Paul H. Allen 2704.* Previously known only from Costa Rica.

RUBIACEAE

(P. C. Standley)

ISERTIA HYPOLEUCA Benth.—BOCAS DEL TORO: Nances Cay Island, *H. von Wedel 580,* Sept. 2, 1940. Previously known from Colombia and other South American countries.

GUETTARDA CRISPIFLORA Vahl.—BOCAS DEL TORO: Isla Colón, *H. von Wedel 508a,* Aug. 20, 1940. Previously known from Costa Rica and the West Indies.

ALLENANTHUS ERYTHROCARPUS Standl.—This well-marked genus has been known from the single type collection, and still has been collected only in the region of the type. An additional collection of it is worth reporting: COCLÉ: Region of El Valle de Antón, trail to Las Minas, alt. about 700 m., Sept. 1941, *P. H. Allen 2713.* A tree of 8–25 m.; fruits pink to red; trees abundant and conspicuous along the upper reaches of the Río Antón.

RUDGEA SKUTCHII Standl.—COCLÉ: hills north of El Valle de Antón, trail to La Mesa, alt. about 1000 m., Aug., 1941, *P. H. Allen 2699.* A shrub 3 m. tall, the flowers white. Described from the vicinity of El General, Costa Rica, and known heretofore only from the original collection.

CUCURBITACEAE

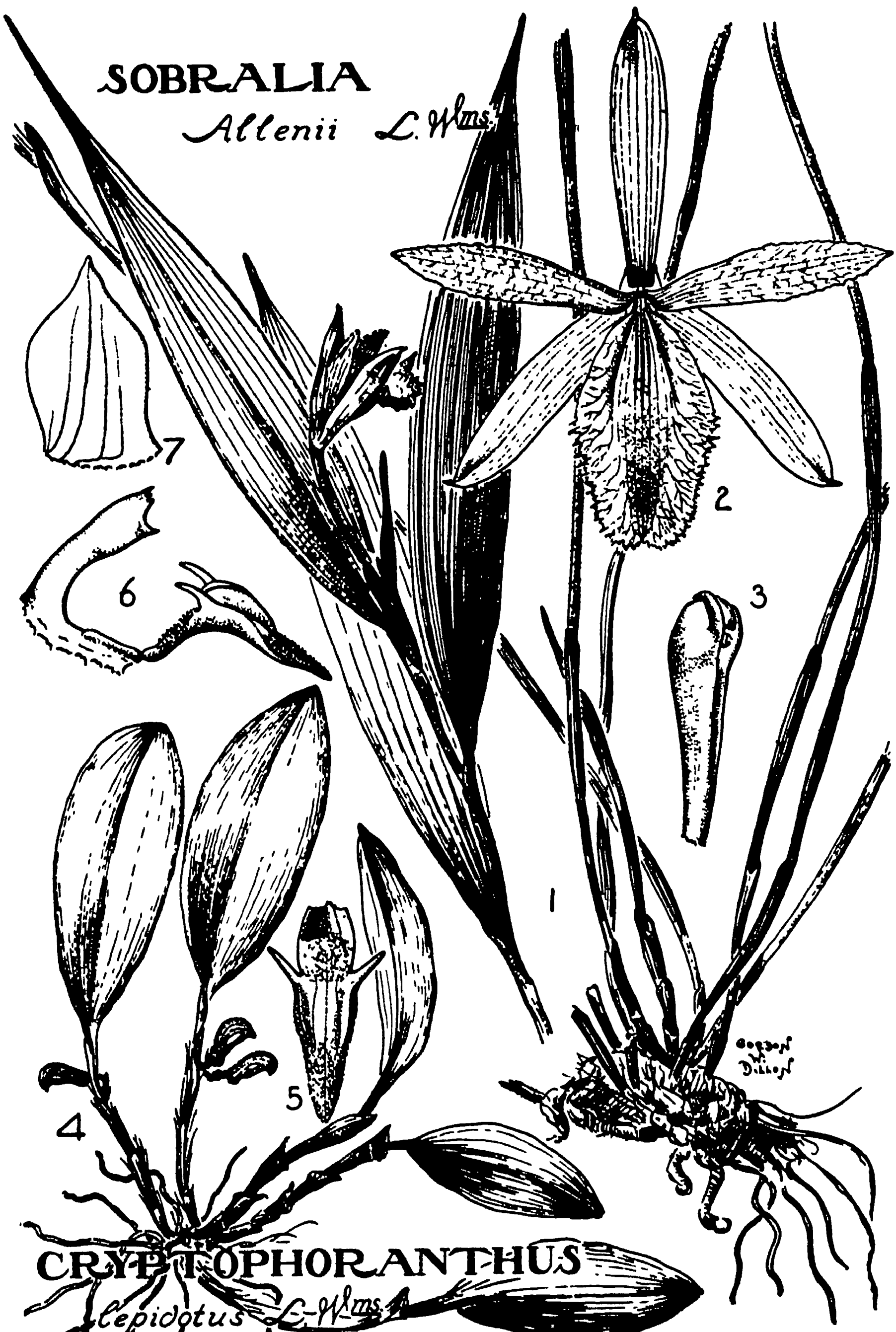
SELYSIA PRUNIFERA (Poepp. & Endl.) Cogn.—BOCAS DEL TORO: Water Valley, Nov. 13, 1940, *H. von Wedel 1596*. Standley reports that this is the first record of this genus north of South America. The species was previously known from Peru.

EXPLANATION OF PLATE

PLATE 30

Figs. 1–3. *Sobralia Allenii* L. Wms.: fig. 1, plant, × ½; fig. 2, flower with segments expanded, × 1; fig. 3, column, × 2.

Figs. 4–7. *Cryptophoranthus lepidotus* L. Wms.: fig. 4, plant, × ½; fig. 5, lip, × 5; fig. 6, lip and column from the side, × 5; fig. 7, petal, × 5.



WOODSON & SCHERY—FLORA OF PANAMA

EXPLANATION OF PLATE

PLATE 31

Sobralia decora var. *aerata* Allen & Williams: fig. 1, plant, × ⅓; fig. 2, lip expanded, × 1; fig. 3, lateral sepal, × 1; fig. 4, petal, × 1; fig. 5, dorsal sepal, × 1.

SOBRALIA *decora* Batem
var. *aerata* Allen & Williams

WOODSON & SCHERY—FLORA OF PANAMA

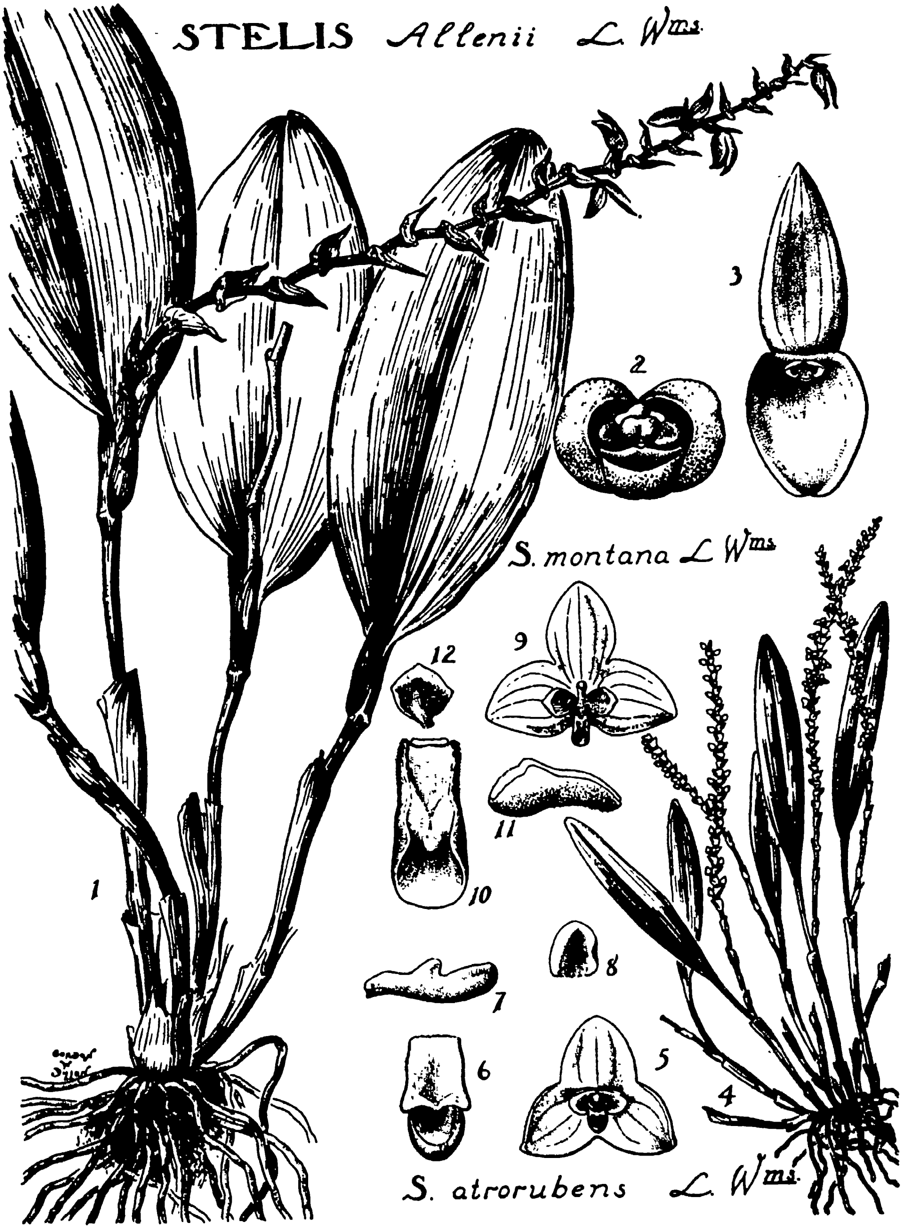
Explanation of Plate

PLATE 32

Figs. 1–3. *Stelis Allenii* L. Wms.: fig. 1, plant, × ½; fig. 2, column, petals and lip seen from the front, × 8; fig. 3, flower expanded, × 2.

Figs. 4–8. *Stelis atrorubens* L. Wms.: fig. 4, plant, × ½; fig. 5, flower expanded, × 5; fig. 6, lip from above, × 10; fig. 7, lip from side, × 10; fig. 8, petal, × 10.

Figs. 9–12. *Stelis montana* L. Wms.: fig. 9, flower expanded, × 2½; fig. 10, lip from above, × 10; fig. 11, lip from the side, × 7½; fig. 12, petal, × 5.



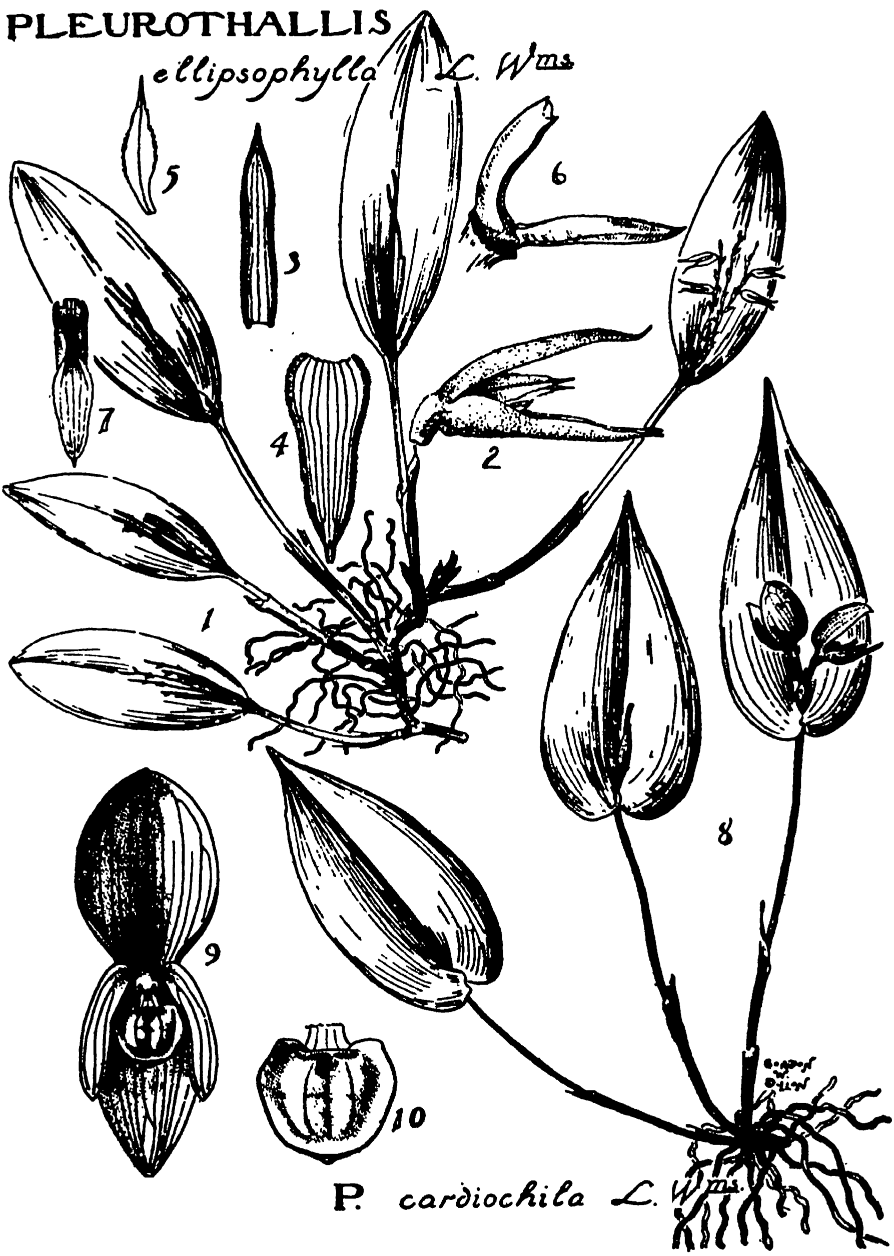
WOODSON & SCHERY—FLORA OF PANAMA

Explanation of Plate

PLATE 33

Figs. 1–7. *Pleurothallis ellipsophylla* L. Wms.: fig. 1, plant, × ½; fig. 2, flower from the side, × 2½; fig. 3, dorsal sepal, × 2½; fig. 4, lateral sepals, × 2½; fig. 5, petal, × 2½; fig. 6, lip and column from the side, × 5; fig. 7, lip from above, × 5.

Figs. 8–10. *Pleurothallis cardiochila* L. Wms.: fig. 8, plant, × ½; fig. 9, flower expanded × 1½; fig. 10, lip, × 3.



WOODSON & SCHERY—FLORA OF PANAMA

EXPLANATION OF PLATE

PLATE 34

Platyglottis coriacea L. Wms.: fig. 1, plant, × 1; fig. 2, column and lip from the side, × 3; fig. 3, column from front with the lip bent down, × 3; fig. 4, dorsal sepal, × 3; fig. 5, petal, × 3; fig. 6, lateral sepal, × 3; fig. 7, anther from below, × 10.

WOODSON & SCHERY—FLORA OF PANAMA

GENERAL INDEX TO VOLUME XXIX

New scientific names of plants and the final members of new combinations are printed in **bold-face** type; synonyms and page numbers having reference to figures and plates, in *italics;* and previously published names and all other matter, in ordinary type.

A

B

C